POWER

Volume 52 New York, August 31, 1920 *Number* 9

I am Power

By Ralph B. Mix

LONG ages have I roamed the Universe, at will. Hither and yon, free and unchecked, Monarch of Earth, and Sky, and Sea. I dwell in the air, among the stars, in the seas, and in every atom and molecule that makes up this place that Man calls Earth. I am omnipotent, and omnipresent.

For ages have I watched the puny efforts of Man, and laughed him to scorn. I used to roam about his habitation, Earth, peeping at him from every rock, and tree; darting down to him from the skies; mocking him, and challenging him to follow me. Yet Man knew me not. His eyes were blinded with a false sense of his own greatness. He gloried when he had felled a single tree, and lo, I swept a forest from my path. He moved a rock, by dint of much effort, and lo, I moved a mountain from its base. He travelled a few weak miles in a day, and lo, I flashed across a continent in an instant. He piled a few rocks and trees upon each other, and called it a home, and lo, I dwelt in the Infinite Spaces of the Unknown.

Man was my slave, my plaything. He bowed down to me and obeyed my will. I tore his habitations, the works of his hands, from their places. I destroyed him with fire. I took his life. I was at once his Master, and his God.

Then Man began to think. One day I was roaming the Heavens, as was my wont; darting to Earth and back again, in capricious freedom, toppling over the works of Man, as a teasing youth would topple over the block castles of a child, when Man, my slave cried out as I passed, "Come hence. I would know you better." I was appalled at his audacity, furious with anger. I rushed Earthward, vowing to myself, "Now will I destroy this Fool, once and forever." And lo, I could not. For Man had discovered my secret powers. Man had begun to think.

And now, alas, what has Man done. He has rebelled against me, captured me, and made me his slave. He has taken away my right to destroy at will. He has perfected methods, whereby his handiwork is protected from my caprices. He has chained me to every Man-made device known to him. I serve him in city, town and hamlet. I run his factories, and I work his farms. I toil where once he labored by the sweat of his brow, while Man sits by, and controls me with a touch. I gave him light to add more hours to his day. I prepare and cook his foods. At his bidding I exhilarate Life, and at his bidding I destroy life. I carry his voice from ocean to ocean, and from continent to continent. I lift him, and convey him o'er land and sea, yea even through the skies, where once I reigned supreme. Daily, he is devising new tasks, new duties, for me, seeking to find my limitations, that he in turn may laugh. But, Ah! he never can.

Man, with all his new found talents, can never conquer me. Let him study and experiment. I shall remain a Mystery. Let him seek to destroy my limitations. I have none. I am omnipotent. I am All and in All. Let him devise new tasks and new labors for me, daily, for a million years. I shall carry them all into fulfillment and laugh. Man has chained me, made me his slave, yet never will he understand, whence I came or whither I go. Man still bows in admiration before my accomplishments, and still I laugh. Man has controlled, but he can never conquer.

I AM POWER.

Soot and Its Abatement by the Use of Salt

By B. S. MURPHY
Superintendent of Power, Hudson and Manhattan Railroad Company

THE Jersey City Power Station of the Hudson & Manhattan Railroad is an anthracite-burning plant using the small steam sizes of coal, and on account of the high draft necessary to get the desired rating—200 per cent or over—a large amount of the minute coal particles, more or less consumed, are blown out of the boiler furnaces and lodge on the heating surfaces as flue ashes or soot. Some eighteen months ago we made experiments on the removal of this material by means of the gases produced by the burning of common salt in the boiler furnaces. These experiments were so successful that they have been incorporated as part of our regular boiler-room routine. Though all our experiments were with anthracite, the results would without doubt be applicable to bituminous coal, which gives a different soot-end product.

True soot is an amorphous carbon, but in the following we will use the term in a much broader sense. We will consider that soot is all the solid matter that leaves the ignited fuel bed with the gaseous products of combustion. Part of this solid matter will be combustible; this will be carbon deposits in some form, and the rest will be more or less incombustible "flue ash." The carbon deposits will be those that escape combustion in the furnace and find lodgment in such locations that there is not enough heat to ignite them or there is insufficient oxygen to support the combustion if ignited, this latter being due in many instances to the covering of the carbon after lodgment with an insulating layer of ash from itself or by further deposits of soot in the form of flue ash. The kind of fuel and the nature and magnitude of its impurities will be the controlling feature in the type of soot deposited, and the amount of these deposits will be governed by the kind and size of the fuel and the operating furnace conditions.

Soot, in its broader sense, includes all solid matter that leaves the ignited fuel bed with the gaseous products of combustion. This article discusses how the amount and character of this material varies with the kind and size of coal, rate of forcing fire and character of service. Some of the troubles due to soot are explained and the method of treatment and results from using common salt are given from actual experience in a large railway power plant.

Bituminous coal or fuel oil will give the true soot or amorphous carbon. The greater the amount of volatile matter the greater will be the quantity given off, and the poorer the furnace condition the greater will be the quantity of carbon that will not be ignited but will be deposited on the relatively cool heating surfaces and, being a good insulator, will have a tenddency to still further decrease the furnace economy. If the furnace condition is as good as possible, some combustion will take place in this mass and the result of this will depend on characteristics of the impurities. If the fusing temperature of these impurities is relatively low, clinker will form, which will in time bridge from tube to tube, seriously increasing the resistance to the passage of the flue gases. On the other hand, with other combinations of impurities the soot may burn to a soft dust, which, while an insulator to heat, does not adhere so strongly as the clinker or carbon soot.

The soot-end product from the combustion of anthracite will be in a variety of forms that will not have much resemblance to each other. The combustible soot, in place of being the soft sticky flakes of amorphous carbon, will as a rule be small, hard, tough granules of coke. The extent of this deposit will depend on the size of coal and the combustion rate, and for the small sizes and high rates there will be enormous quantities to be disposed of, much greater than will be found with the soft coal in stationary practice, and as a rule much greater than the non-combustible portion. To give some idea of the quantity of this combustible soot and its heat content, when the Jersey City Station boilers were hand-fired a serious attempt was made to reburn this soot, and it may be of interest to note the results of a boiler trial with soot as a fuel. The general boiler data are given in Table I.

TABLE I. HAND-FIRED BOILER DATA

Make	B. & W. 900 hp. horizontal water tube
Working pressure, lb. sq.in	180
Heating surface	Four drums, 42 in. dia. x 23 ft. long; 432 4-in. tubes, 18 ft. long. Total surface, 9,000 sq.ft.
Grates	Four doors per boiler, 190 sq.ft. of surface, inclined dumping grates.

The boilers at this station were erected with the soot requirements in view and have an extra-large combustion space in back of the bridge wall, which has a chute at the bottom leading to the narrow-gage ash tracks in the basement. The soot from these chambers was run into the ash cars and from them dumped into the coal hoist and elevated to a special bunker, then passed through a grinder, where it was mixed with bituminous coal and then hand-fired in the regular manner. The results of one of several of such trials is given in Table II.

TABLE II. TEST WITH SOOT AS FUEL

Date	Dec. 4, 1912
Duration of test, hours	8
Dry soot fired, lb	23,196
Bituminous coal mixed with soot, lb	4,446
Bituminous coal mixed with soot, per cent	16.2
Total fuel, lb	27,642
Actual water evaporated, lb	208,894
Actual evaporation per pound of mixture, lb	7.55
Water evaporated from and at 212 deg. F., one pound of mixture	8.40
Boiler horsepower developed	843
Corresponding rating, per cent	93.9
Ash, ratio of weight of refuse from the ashpit to the weight of the mixture, per cent	14
Soot, ratio of the weight of soot removed from the rear connections to the weight of mixture, per cent	17
Refuse, total of ash and soot, per cent	31

From these data and comparisons of costs it would appear that we could almost cut the fuel cost in two by the use of the soot mixed with the bituminous coal

as a binder. However, in 1913 we had to abandon this, as the firemen were working in this soot up to their shoe tops at all times and could not be induced to continue the work. In smaller plants it could be used by mixing in with the anthracite coal on the floor, but in these cases the boiler rating is usually too low to make large quantities of soot. In large installations if a cheap binder was available it would make good briquets.

The Incombustible Portions of Soot

The incombustible soot from anthracite resembles the bituminous flue ashes chemically, but is found in a vast variety of different forms—red, brown, gray and black granules or in dust of these colors, and also forms the clinker on the heating surfaces or furnace masonry and is equally as good an insulator for heat transfer. The form varies with the size of the coal particles and the furnace-operating conditions, while the color will depend on the chemical make-up of the impurities. The formation of the clinker will depend on the furnace temperature and on the fusing point of the ash.

There is little to choose between the incombustible anthracite or bituminous soot. The combustible soft-coal soot adheres to and covers more surface than that from hard coal and is, perhaps, for this reason, a better heat insulator, but the latter under high rating is vastly more in volume, in stationary plants, and for this reason is more bothersome.

The Soot Problem in Locomotive Practice

In locomotive practice, with the extremely high rates of combustion and the necessary draft, great quantities of soot are made with soft coal—quantities that equal in volume, if they do not exceed, that from the small sizes of anthracite in stationary plants. Some interesting data were found on the magnitude and make-up of this locomotive soot during the locomotive tests of the Pennsylvania Railroad in St. Louis in 1904. At the locomotive test plant the engines were so arranged that all the soot would be retained. Before the test started, the front end was cleaned, and after the run the resultant accumulation of cinders was removed and weighed. The lighter portions or sparks were caught in a smoke jack arranged with baffles and located over the locomotive stack. The combined weight of these two gave the amount of soot for the trial. The quantity was found to vary with the type of locomotive and in the same locomotive with the speed and load. In fact, many tests had to be abandoned on certain engines, owing to the front end filling up to such an extent as to completely kill the draft. This was especially true on the German engine tested, and to some extent on a French engine, as both of these were designed to use briquets in place of the run-of-mine bituminous used at the plant.

Locomotive Soot Data

To give an idea of the soot features of locomotive practice, Table III shows a rather excessive case found in testing the DeGlehn four-cylinder balanced compound, Atlantic-type engine, P.R.R. 2512, Test 510. This pictures the locomotive soot question in a most severe case. Ordinarily, the percentage of the front-end refuse would run about the same as for an anthracite stationary installation with the small sizes and high ratings, say from 5 to 12 per cent for the fuel fired. The calorific value of the soot given is rather lower than the average, and the variations will be from these figures to as high as 13,000 B.t.u. for coal of about the value given in the table.

In firing anthracite coal the amount of soot depends largely on the draft. Under hand-fired conditions the draft will depend largely on the load and to a certain extent on the burning characteristics of the fuel. At the Jersey City station hand firing was originally employed, using screenings of about the following make-up: 2 per cent through a $\frac{8}{16}$-in. and over a $\frac{8}{32}$-in.

TABLE III. LOCOMOTIVE CINDERS AND SPARKS

Speed of locomotive, equivalent m.p.h.	57.4
Revolution of drivers, r.p.m.	140
Draft in smoke box, w.g. inches	1.64
Furnace temperature, deg. F.	1,737
Smoke-box temperature, deg. F.	558
Rate of combustion, dry coal per square foot of grate surface per hour, lb.	52.74
Duration of test, minutes	120
Coal fired, lb.	3,651
Cinders and sparks (soot), lb.	1,227
Cinders and sparks, per cent of coal	33.6
Kind of coal	Scalp level—run-of-mine bituminous
Calorific value, dry coal, B.t.u. per lb.	14,892
Calorific value of cinders, B.t.u. per lb.	10,655
Calorific value of sparks, B.t.u. per lb.	8,958

screen, 4 per cent through $\frac{8}{32}$-in. and over $\frac{8}{32}$-in., 39 per cent through $\frac{8}{32}$-in. and over $\frac{8}{32}$-in. and 55 per cent through $\frac{8}{32}$-in. The load had morning and evening peaks requiring operation at 120 to 130 per cent of rating for periods of 1½ hours. To carry this load required a draft of 6 to 7 in. of water, and a large amount of leveling of the fires was necessary.

Specific Firing Conditions Favor the Formation of Soot

The condition in the furnace became analogous to the burning of pulverized fuel, a relatively large amount of the coal never striking the grates at all, but igniting in the air as it left the fireman's scoop. Some particles are completely consumed in this manner, while others are only coked and are carried by the excessive draft over the bridge wall, where some lodge. The rest goes through the different passes with more or less finding lodgment on the heating surfaces; a still smaller amount lodges in the economizer, and finally some goes up the stack. Every time the leveler is used, it stirs up a small cloud of minute coal particles, and of course whenever a hole develops in the fuel bed, a miniature volcano is formed, adding its quota to the mass of suspended fuel.

The result of all this was that we had to contend with enormous quantities of flue ashes and coked coal, which at times would be as much as 12 per cent of the fuel fired. Our boiler installation was designed with this in view, and we have extra-charge soot chambers back of the bridge wall connected by pipe chutes with the ash basement, so that this accumulation may be run off two or three times a day the same as the furnace refuse. This took the bulk of the soot, although there was a large quantity that never reached the soot chamber but lodged on the tubes. This we attempted to remove with a hand lance, the boilers not being equipped with mechanical soot blowers.

Effect of Stokers on the Soot Problem

These boilers have now all been equipped with stokers, and the formation of soot is reduced in quantity. There is not the original opportunity for the air to get under the small coal flakes as they enter the furnace, and as there is no leveling required the surface of the fire is not being continually agitated

and the small particles broken loose. On the other hand, the stokers are worked to higher ratings, over 200 per cent, for longer time periods, and even with the most careful regulation of the air and the depth of the fuel a certain amount of the coal is always being blown off.

The result is that from a maximum of 12 per cent and an average of about 6 per cent, with hand fires, the amount that we can classify as soot with the stokers has been reduced to about 7 per cent as a maximum and 3 per cent as an average. However, that is not all gain, for some of the soot is now mixed with the ash, having a tendency to increase the combustible in the ash. This is due to the ash space at the back of the grates that allows the soot that falls short of the bridge wall to fall into the ashpit. From this it is apparent that a considerable step in the soot reduction with anthracite is the doing away with hand fires and going to stokers, but there is still enough made to impair the steaming quality of the boilers by insulating the heating surfaces and choking off the draft.

A New Trouble Peculiar to Stoker Operation

There is, however, another trouble with soot that bothers more with stokers than with hand-fired boilers; that is, the formation of long clinker, or what is locally known as "whiskers." These clinkers start at the side walls, arches or tubes and grow until at times they are 6 in. long on the side walls and 18 to 24 in. on the arches or tubes. The side-wall formation interferes with the contour of the fire and at the same time causes holes through the fuel bed along the sides of the grates, and of course the clinker on the arches and bridged across the tubes obstructs the free passage of the gases and also has a tendency to cause masonry failures if the growths become too great.

These clinkers cannot be called soot, but their formation is from the same cause, the blowing about of the small ignited coal particles that adhere to the interstices of the brickwork or to the metal of the heating surface and the ash from which, when in contact with the firebrick, tends to fuse the two together, possibly at a fusing temperature lower than either would fuse by themselves. There is some of this clinker formation found in hand-fired boilers, but not to so great an extent as with the stokers. This is due to the much greater furnace temperature usually found in the stokers. In order to avoid this growth at the fire line, we use in the stokers two courses of carborundum brick, which on account of their greater fusing temperature have not quite the tendency to start the clinker. Another advantage of the special bricks is that, due to their greater mechanical strength, there is not as much danger of their spalling under the rough handling necessary to knock off the clinkers after they once form.

Effect of Soot Deposition on Heat Transmission

With hard coal it is absolutely necessary to remove the bulk of the soot by mechanical means; it has to be handled like so much ash from the furnace, but with both coals some special means must be used to clean the fire side of the heating surfaces or else the soot will insulate these surfaces to such an extent as to cut down the boiler efficiency. Actually, we may find a difference of from 50 to 100 deg. F. in flue-gas temperatures between a sooted and a clean boiler, which perhaps will account for a loss of from 0.5 to 3.0 per cent in over-all boiler economy. If we assume that this loss would be 2 per cent and that the plant was using coal at $4 per 2,240 pounds, then per 1,000 boiler horsepower of output we would look for a saving of 18 cents. This figure in itself appears small, but it will more than pay for the salt used for cleaning the heating surfaces. The increase in the boiler output, the decrease in the time out for external cleaning and the freedom from the clinker formation would be clear gain.

Some Troublesome Features from the Operation Standpoint

The foregoing effects of fouling pertain to the results on the boiler-operating efficiency as effected by the reduction in the heat transfer due to poorer conduction and may be considered for this reason as bearing more on the fuel costs than on the boiler-operation conditions in the boiler room. From the operation standpoint the two most troublesome features are the bulk of the soot, both combustible and noncombustible, in the case of the small sizes of anthracite, and the clinker formation from both bituminous and anthracite.

The great bulk of the hard-coal soot has to be met with when high ratings and small sizes are used, and no soot blower or other apparatus will help in the slightest. It has to be considered the same as the excessive refuse when using coals high in ash and handled in a similar manner; it must be removed as often as possible, at least every watch, and every installation will have to be considered by itself for the most economical method of handling, and this may broadly be divided into getting it out of the boiler and then getting it away from the plant. The clinker formation on the tubes and heating surfaces may be kept down to a minimum by the use of mechanical soot blowers, but only where the jets from such blowers may reach; this still leaves a large surface for their growth, with the resultant evils. The clinker formation on the arches and side walls will not, as a rule, be affected by the jets from a soot blower, and this is one of the worse conditions.

Salt Treatment Suggested by United States Railroad Administration

We first experimented with the use of salt for cleaning the fire surfaces on the recommendation of the Mechanical Section, Division of Operation of the United States Railroad Administration, in January, 1919, on our hand-fired boilers at the Jersey City Station. At this time we were short on boilers in the middle of winter, with very poor labor and poorer coal, and the boilers were all very badly sooted up. The result was apparently a dismal failure, for we could notice no great removal of clinker or soot, and apparently it adhered as strongly as ever. However, we did not consider that we had given the method a fair trial, so after taking the boiler out and giving it a good external cleaning, we salted regularly until the next cleaning. During this period of 22 days, covering 528 hours, a total of 500 lb. of salt was used at intervals varying from 72 to 240 hours. As a result the metal surfaces were much cleaner than usual and where the clinker formation did exist it was easily broken off. This was especially noticeable up in the tube bank itself, where the surface is almost im-

possible to reach by hand. At this time we were changing over all the boilers from hand-fired to stokers, and as the salting worked out so well, we then adopted it as part of our boiler routine with the stokers, as well as with the remainder of the hand-fired units until they were changed.

The general method of using the salt with the hand-fired boilers, was as follows: At some off hour during the day, when the boiler may be spared from steam making, about an hour and a half before the cleaning of the fires, the draft was removed and the fire banked. The charge of salt was then spread evenly over the whole surface of the fire, and the draft was not returned or any coal added until all the fumes had disappeared and no sign of salt remained on the fuel bed. The action may be noticed for one-half to one hour after the application. From time to time the leveler is used, as the reaction slows, to stir up the salt that may have some tendency to cake over. The fire is then cleaned in the regular manner, built up and returned to steam making. The salt deadens the fire, and as no coal may be added during this cleaning period the treatment should be given only at such times as the boiler may be spared.

Salt-Treatment Methods with Stokers

With the stokers the method has to be modified but slightly. The coal gates on the chutes leading to the spreaders are closed, the contents of the hoppers run out and the draft shut off. The front is then lifted down and the salt spread evenly over the surface of the fire with a scoop the same as for a hand-fired furnace, leveled when necessary to completely consume the salt. When all the gases have been dissipated, the front is lifted back into place, the coal gates are opened, draft cut back, grates put in motion and the boiler returned to steam making again.

All this work is done by the stoker operators, so there is no additional labor charge and, better yet, there is no difficulty in getting the men to do this, for it is not laborious and they soon see that it is a help to themselves. With other types of stokers than chain grates some little modification would be necessary, but this is fairly simple for any installation.

Best Results from Ice-Cream Salt

Some of our first experiments were with rock salt, and apparently this is not quite so efficient as ice-cream salt, as there may be a greater moisture content in the former, this having a tendency to add clouds of steam to the gases, which are at the best inert. We have also used a cheap grade of granular salt, but apparently the results are not so good.

Our practice now is to give each boiler on the line one hundred pounds of ice-cream salt every seven days, the salt often used as we receive it, although it is good practice to keep some quantity ahead in a dry place. This would make for one month, or the scheduled period between external cleanings, about four hundred pounds of salt, and the ratio and costs are given in Table IV.

TABLE IV. SALT USED PER MONTH PER BOILER

Kind	Ice cream
Amount in pounds	400
Amount per square foot of grate surface, lb	1.75
Amount of square foot of heating surface, lb	0.045
Amount per 100 horsepower of builder's rating, lb	45
Cost of salt per pound	$0.01225
Cost of salt per month	$4.90
Cost of salt per 100 hp. of builder's rating per month	$0.55

We figured before that we could expect a tangible saving of 18 cents per 1,000 boiler horsepower delivered, with vastly more than this that we could not express in dollars and cents. Then, at this rate of output, for thirty days the saving would be approximately $130 and the cost of salt $5.50. Of course this difference is not all net gain, because other means of cleaning are necessary, and if for this reason we assume that we gained only one-half of this saving by the salt, or $65, we would still have a wide margin to cover the cost of the salt.

Theory of the Action of the Salt

The action of the salt in the removal of soot is primarily chemical, for the salt when spread on the fire is broken up by the action of the heat into its components of sodium and chlorine, both in their gaseous state, and it is the reaction of these gases on the soot, both the combustible and non-combustible, that is depended on for the cleaning. It is for this reason that by the use of salt we can get results that are impossible from any mechanical or manual cleaning, for these gases will travel over every square foot of the heating surface and reach locations impossible of access by any other means.

As mentioned before, the flue ash, and especially the clinker make-up, is much more complex than the combustible soot and consists of silica (SiO_2), alumina (Al_2O_3) and iron oxide (Fe_2O_3). We must, therefore, have a reaction that will support and augment combustion to dispose of the combustible or carbon portion and also gases that will chemically react with the clinker formation so as to dispose of them. Both of these requirements are very well found in the gases from the destruction of the salt.

Action of the Chlorine Gas

The chlorine gas on account of its acidic characteristics will react with the iron oxide of the clinker, forming ferric chloride, which should burn off at the high temperatures found after the boiler is taken off the bank; this will cause a disassociation in the mass of the clinker, making it fragile and incapable of sustaining its own weight, thus causing it to fall. This is especially true with the clinker formation on the tubes or other iron surfaces, where the reaction will take place at the base of the mass or the junction of the clinker with the more or less oxidized iron surface, and will undermine the structure. Hydrochloric acid will throw down the SiO_2 out of composition, and owing to this reaction there will be set up in the mass a considerable mechanical tension, which will break off the "whisker" or at least make it adhere less strongly. Either or both of these reactions are enough to destroy or weaken the clinker and make it capable of removal by some mechanical means, as a steam jet, so it is immaterial whether any reaction takes place with the alumina.

The foregoing is what we consider takes place with the incombustible portion. It cannot do the impossible, consume incombustible matter, but it does break it down from the heating surfaces or masonry and make possible its removal by some mechanical means, and in many instances the residual fine dust is actually carried away by the velocity of the furnace gases of combustion.

The action during the salting period is quite noticeable, and for some three to four hours after the boiler

is returned to steam making it will be noticed that clinker and dust are falling on the grates.

We have found the results most beneficial, so much so that the fireroom crew will soon complain if by any chance the salt supply is allowed to run out. We consider that this in itself is about the best proof of its benefit and that it shows the ease of application, for the present-day laborer is not looking for extra duties unless he can notice the benefit to himself.

Actual Results from the Treatment

We do not claim that this method is a cure for all soot difficulties. It is not. Neither do we advocate the abandonment of all mechanical cleaning methods, either while the boiler is in service or when out for its regular external cleaning. We do claim that it removes from the heating surfaces and the furnace walls a large amount of clinker and soot, that it removes soot from locations it is impossible to get at by hand or other mechanical means, that it loosens the clinker and the adhered flue ash from the furnace and boiler surfaces so that it may be readily blown off by a steam jet for the daily cleaning, from the furnace walls, so that where necessary it may be broken off by a slice bar with less ill effects to the masonry and from all surfaces that are gone over during the external cleaning. We advocate the continued use of the hand lance for installations that are not equipped with mechanical blowers.

A Diesel Engined Flour Mill

UNTIL four or five years ago the majority of the flour mills of the country were driven by Corliss engines. Although the power cost per barrel of flour ranged from 20 to 30 cents it was generally assumed that no other prime mover could compete with the Corliss engine. Increasing coal prices and higher labor charges now compel the mills to give more attention to power plant companies. The favorable results secured in other industries where Diesels have been installed have caused a considerable demand for oil engines in the mills.

A great number of the smaller mills of less than 100 horsepower capacity have installed hot-bulb or surface-ignition engines. The somewhat high fuel consumption of this type together with certain inherent characteristics that are peculiar to the surface-ignition engine prevent its employment in the larger powers. As a result the Diesel engine has been chosen in the larger mills.

Kept Accurate Operating Data

It is always difficult to secure actual data on Diesel plants and most of the information that has been published has been based on estimated costs. Fortunately the Page Milling Co. of Topeka, Kansas, have kept accurate data on the power costs of their Diesel engined mill. Their figures are tabulated herewith. This mill contains a 385-hp. McIntosh and Seymour four-cylinder vertical Diesel which drives the mill machinery through a rope transmission system. The engine has been in operation for four years and runs twenty-four hours a day, being shut down on Sunday. During this period the load was varied from 50 to 80 per cent of the engine rating, the average load being about 65 per cent. Much of the excellent service secured is due to the fact that the engine has never been overloaded. In this matter the Page Co. emphasizes the necessity of always having the engine capacity greater than the load requirement.

During 1919 the power costs were as follows:

Barrels of flour, bbl.	124,000
Wages, per bbl. flour, in cents	3.82
Fuel oil, per bbl. flour, in cents ($1.58 per bbl.)	2.21
Lubricating oil, per bbl. flour, in cents	.37
Incidentals, per bbl. flour, in cents	.13
Repairs, per bbl. of flour, in cents	1.78
Depreciation, 10 per cent per bbl. of flour, in cents	2.23
Interest and taxes, 8 per cent per bbl. flour, in cents	1.78
Total cost in cents	12.19

The item of repairs is somewhat larger than is customary. This covers the expenses of a man from the factory to install new camshaft gears and replacement of the steel support of the main driven rope sheeve.

The fuel oil was purchased at a contract price of $1.58 per barrel. At present the open market quotes oil at $3.65. The difference increases the fuel cost to 5.89 cents per barrel of flour and the total power charge becomes 15.09 cents. This compares more than favorably with a steam plant which can hardly do better than 30 cents per barrel with coal prices at the present level. The repair charge will not exceed those of a steam plant. The wage charge is commendable as it indicates that the plant force are receiving wages that are equal to those paid steam plant engineers.

Troubles Were Not Serious

During the four years of operation no serious troubles have occurred. The principal difficulty has been the wear of the camshaft gears. The helical teeth tend to force the vertical governor shaft and the camshaft apart. The upper governor shaft bearing wears rapidly, but has now been replaced by a babbitted bearing. The engineer formerly in charge of the plant ran the engine with excessive clearances between the valve rocker arms and their respective cams. This served to place strains on the gears which increased the wear of the gear teeth. The gear teeth are now lubricated through an oil line from an overhead tank; a heavy stream of oil is deposited on the teeth as they come into mesh.

The main pistons apparently have worn but little; all the rings have been renewed once, with the further renewal of nine more rings during 1920. No bearing trouble has ever been experienced. The engine's operation is very satisfactory and it is possible that 10 per cent is entirely too high a charge for the wear on the engine.

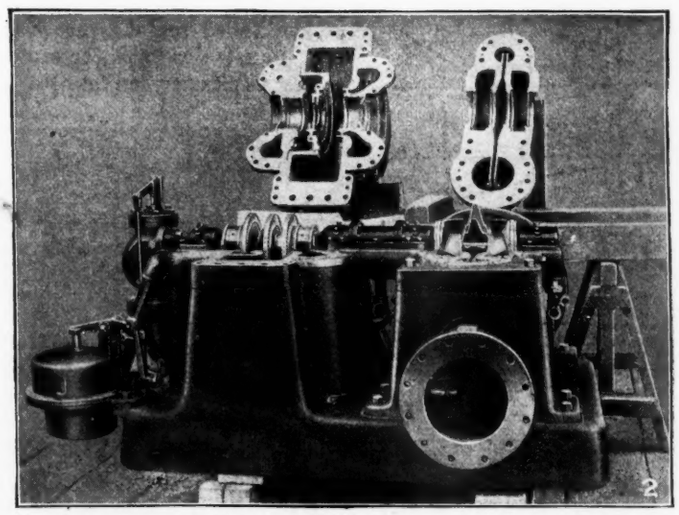
The engineer who is accustomed to large airy engine rooms would probably criticize the cramped quarters. The engine room is very limited; the working space about the engine is entirely out of keeping with the investment in the engine. Diesel engine rooms should be generous in proportion, since many times parts of the engine must be handled quickly. The visitor is struck with the position of the exhaust pipe. This pipe is entirely within the engine room, the exhaust pipe passing through the roof. As a consequence the roof and side walls have caught fire. In erecting a Diesel plant the exhaust should pass out of the engine room before entering the exhaust pot. One very destructive fire occurred in a pipeline pumping station because of this defect.

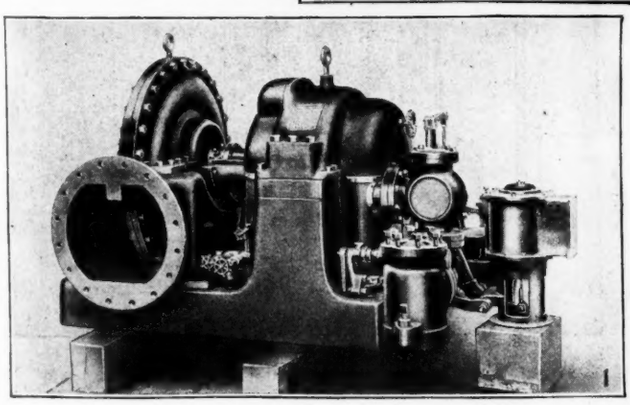
The record of this plant is noteworthy. Such plants tend to overcome the prejudice of the steam engineer. Few, if any, steam plants can show a year's record of repair costs as low as does this plant. With coal prices advancing the flour mills will do well to investigate the Diesel engine.

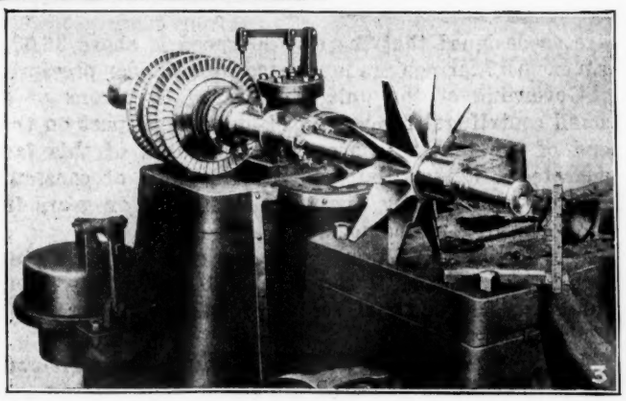
Single-Stage Turbo-Blower Operating Normally at 22,000 R.P.M.

Capable of Compressing in a Single Stage 4,000 cu. ft. of Free Air per Min. to 21 lb. per sq. in. with the Rotor Running at a Tip Speed of 1,400 ft. per sec.—The Turbine Develops Normally 300 hp. and Weighs 6.7 lb. per Horsepower

HIGH-PRESSURE superheated steam, the steam turbine and alloy steels have made possible rotative speeds that a few years ago were beyond the engineer's wildest dream, and the speed at which steam turbines and other power machinery operate, are being increased. There was recently designed and built by the Rateau Battu Smoot Co., New York City, a turbo-blower, Figs. 1 to 3, that operates at a normal speed of 22,000 r.p.m. and when tested before shipment, to the Famatina Mining Co., Argentina, S. A., was operated at 26,000 r.p.m. When operating at 22,000 r.p.m., this machine will compress in a single stage 3,000 cu.ft. of free air per minute to 15 lb. per sq.in. It is difficult to comprehend just what a speed of 26,000 r.p.m. means. In the short period of one second, the time that it takes the second hand on a watch to move one division, the rotor makes 433 revolutions. The diameter of the turbine's motor is 9¾ in. and that of the blower 12½ in. At 26,000 r.p.m., this gives a tip speed to the latter of 1,400 ft. per second. If it were possible for this rotor to run across a plane surface, it would travel at the rate of 16 m. per minute, or over five times as fast as the fastest airplane. At this rate it would travel around the earth at the equator, a distance of 25,000 miles, in 26 hours.







FIGS. 1 TO 3. ASSEMBLY AND PARTS OF TURBINE AND BLOWER

Fig. 1 shows the complete unit assembled—turbine on the left. In Fig. 2 the top casing is raised, but in this case the turbine is on the right. The rotor is removed from the bearings and is resting on the lower half of the casing in Fig. 3. The 6-in. rule standing vertical on the right hand end of the casing gives an idea of the size of the revolving element which only weighs 138 lb. One hundred of this is in the turbine rotor and 38 lb. in the blower rotor. The entire machine weighs 5,500 lb. Of the total weight 2,000 lb. is on the sub-base, 1,500 lb. in the blower and 2,000 lb. in the turbine. Since the turbine is normally capable of developing 300 hp. its weight per horsepower is only about 6.7 lb. The old Centennial engine, which was a feature at the Exposition held in Philadelphia, 1876, weighed 1,400,000 lb. and developed 1,400 hp. or 1,000 lb. per hp.; approximately 1 5 0 times as much as the turbine under discussion. In the case of the turbine, the normal speed is 22,000 r.p.m. and that of the old Centennial engine 36 revolutions per minute. As to the compactness of the machine, an idea can be had from the fact that the entire unit can sit in a floor area 7 × 4½ ft.

The entire blower end of the rotor, both shaft and blading, is made from a nickel-chrome-magnesium steel, heat-treated, forging, the radial blades being machined an integral part of the shaft. Such a wheel has the maximum rigidity and is so designed that at all points the stresses are far below the elastic limit of the metal—a factor of safety of 3.5 being used. Some idea of the centrifugal force in the blower blades may be

gained from the fact that one ounce weight on the end of the blade will exert a radial pull of approximately 3.75 tons.

On the turbine end, the rotor has three wheels all machined an integral part of the shaft. This like the blowing rotor is made from a nickel-chrome-magnesium steel heat-treated forging. The blades are machined from a solid bar of the same material used in the wheels and inserted into the latter. The first wheel receives steam at boiler pressure, 150 lb. gage and 100 deg. superheat, and is then discharged to the low-pressure wheels in parallel. Normally the turbine is to operate condensing on a vacuum of 25 inches. When so operated it has a water rate at normal load of 16.7 lb.

Both rotors are connected by a rigid coupling and

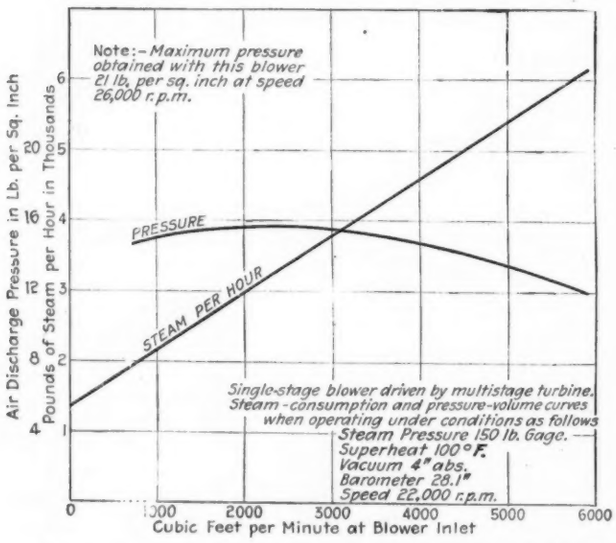

Note:-Maximum pressure obtained with this blower 21 lb. per sq. inch at speed 26,000 r.p.m.
PRESSURE
STEAM PER HOUR
Single-stage blower driven by multistage turbine. Steam-consumption and pressure-volume curves when operating under conditions as follows
Steam Pressure 150 lb. Gage.
Superheat 100° F.
Vacuum 4" abs.
Barometer 28.1"
Speed 22,000 r.p.m.
Air Discharge Pressure in Lb. per Sq. Inch
Pounds of Steam per Hour in Thousands
Cubic Feet per Minute at Blower Inlet
0
2000
3000
4000
5000
6000

FIG. 4. PERFORMANCE CURVES OF TURBO-BLOWER

are so designed that the critical speed is above 36,000 r.p.m. All bearings are lubricated by oil under pressure.

Governing of the unit is obtained by means of a small centrifugal fan machined an integral part on the end of the turbine shaft. The discharge of this fan operates a Rateau Battu Smoot regulator of constant volume, consequently there are no flyballs or gears in the governing mechanism.

The flexibility of this machine is of considerable interest, inasmuch as it can be operated to supply from 1,000 to 6,000 cu.ft. of air at pressures varying from 12 to 16 lb.

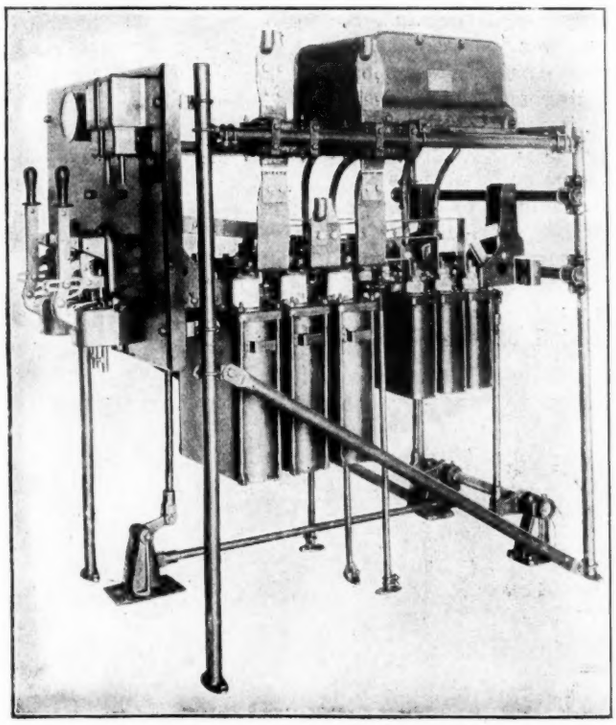
Very elaborate tests were made before shipment and the normal performance of the turbine and blower are shown on the curves, Fig. 4. At a speed of 26,000 r.p.m. the machine delivered 4,000 cu.ft. of air at a maximum pressure of 21 pounds. During its operation at full speed and overspeeds, the machine operated without the slightest vibration, it being quite impossible to obtain readings from a vibration tachometer. The results of these tests show that two machines of this type working in series can be made to compress air to 100 lb. pressure in small units, and three machines in series would give a compression as high or higher than 100 lb. for large size machines.

The Famatina turbo blower is constructed on somewhat similar lines to a machine that has been in operation for more than two years at the plant of the Omaha Gas Co., Omaha, Nebraska.

Low Voltage Panel for Starting Induction Motors

There has recently been placed on the market a line of standard unit induction-motor starting panels for use with either wound-rotor or squirrel-cage motors operating on three-wire non-grounded systems. They are built by the General Electric Co. and designed for such work as controlling motors which are driving compressors, blowers, centrifugal pumps and similar machinery. Protection from sustained heavy overloads is provided by time-limit relays which operate the oil circuit-breakers, but which due to the time-limit feature prevent the motors being shut down on instantaneous overloads. There is also an undervoltage device which opens the breakers in case the line voltage falls to a predetermined value below normal. This prevents the damage that might ensue, if the motor was left on the line when full voltage was re-established and the operator had failed to take the proper precautions.

Panels designed for motors having an internal starting resistance can be fitted with an additional device to



MOTOR STARTING PANEL

insure the proper use of such resistance, so as to protect both the motor and the resistance from damage due to improper starting. This device prevents the oil circuit-breaker being closed until the maximum starting resistance is in the circuit and automatically trips the breaker open, if the motor should be left running with the resistance either wholly or partially in the circuit. Protection of motor start by compensators that do not have self-contained switching arrangements is furnished by a time-limit mechanical interlock which serves several purposes. In the first place, it prevents the closing of the main breaker before the starting breakers have been closed and then opened. Secondly, it insures that the main breaker is closed within a short fixed time after the starting breakers have been opened.

Steam-Engine Operation and Maintenance—Lubrication of Valves and Saving of Used Oil

By H. HAMKENS
Consulting Engineer, Newton, New Jersey

GOOD steam-engine cylinder oil is usually compounded from mineral oil and tallow or tallow oil; it is sometimes adulterated by the addition of cheap vegetable oils. Mineral oil without a certain percentage of animal oil is not suitable for cylinder lubrication, as it is so easily affected and washed off by moisture in the steam. Tallow or tallow oil should not be used alone on account of the fatty acid contained, which would attack the cylinder walls. An all-round mixture that gives good results is 94 per cent of mineral oil and 6 per cent of tallow. The flash-point of cylinder oil, or the temperature at which the vapor of the oil will ignite, should be at least 150 deg. higher than the temperature of the steam entering the cylinder. This point must be taken into account in cases where a change is made from saturated steam to superheated steam, which would also command a change in the lubricant.

Efficient lubrication of the valve or valves of an engine is just as important as that of the piston and cylinder if the valves have sliding surfaces, as the common slide valve, piston and rotary valves. The seats of poppet valves do not require lubrication, in which respect they are much superior to other kinds of valves. Piston valves are easily lubricated as the pressure between valve and seat is slight. The common slide valve, however, requires copious lubrication, more so than any other valve, on account of its long travel and unfavorable position on the side of the cylinder. No lubricant will stay for any length of time on the vertical surfaces of this kind of valve; it runs off and is carried out with the exhaust.

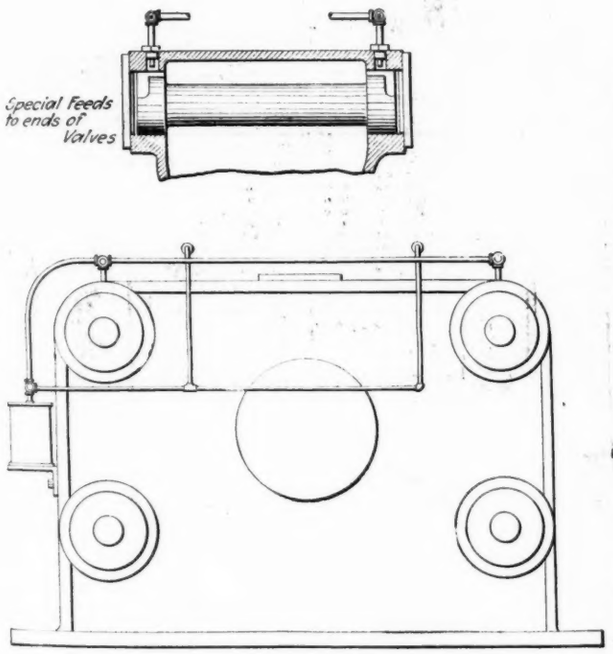


FIG. 1. OILING ARRANGEMENT FOR CORLISS-ENGINE CYLINDER

The lubrication of Corliss valves is often a problem and requires careful study and experimenting, especially on the larger sizes. On account of the great length of some of these valves it is difficult to keep their sliding surfaces covered uniformly with the lubricant. This is particularly true of the ends of the valves which are not touched by the flow of the steam and for lubrication must consequently depend on any small amount of oil which will spread sideways along the seat or depend on a special supply fed to these parts independent of other sources.

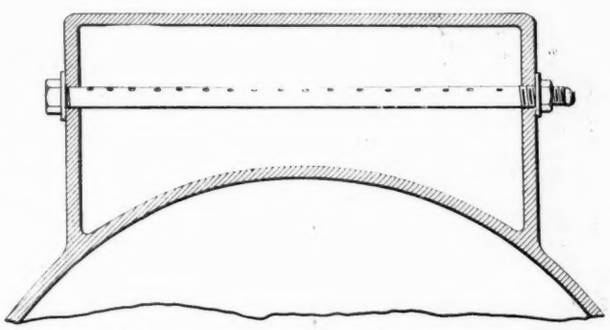


FIG. 2. OIL PIPE WITH SMALL HOLES, LOCATED IN STEAM CHEST

An efficient oiling arrangement for a Corliss-engine cylinder in which particular attention is paid to the lubrication of the ends of the steam valves is illustrated in Fig. 1. The use of a multiple sight-feed oil pump is indicated with one feed for each end of the steam chest and a special feed to each end of the steam valves. The oil fed into the steam chest will be diffused by the steam and serves to lubricate the exposed parts of the steam valves as well as the cylinder and piston, while an occasional drop of oil fed to the valve ends will be sufficient to keep them coated with a film of lubricant. It is only necessary to lubricate the steam valves; the exhaust valves, if placed below the bore of the cylinder, will be sufficiently oiled by the lubricant contained in and carried along with the exhaust steam.

On large Corliss-engine cylinders, 60 in. in diameter and over, one simple oil feed at each end of the steam chest is not sufficient to lubricate the valve and cylinder. The oil must be spread out over the full width of the steam chest. This can best be accomplished by brass pipes, one inserted at each end, as shown in Fig. 2. The oil is forced into these pipes and discharged through a row of small holes in an upward direction. Being well preheated, it is readily taken up and diffused by the steam.

It has been asserted that 50 per cent of the lubricating oil purchased is wasted, and an inspection of some of the old-time engine rooms will probably bear

out the assertion. The conditions in some places are hardly believable and certainly inexcusable, especially if the high cost of oil and availability of modern systems of lubrication and filtration are taken into account. At a comparatively small cost an oiling system that would pay for itself in a year or two could be installed in many engine rooms, not to mention the better service, cleanliness and reduction of wear of the engine parts.

On simple engines a small oil reservoir of four or five gallons' capacity can be placed on a stand and fastened to the frame of the engine, as shown in Fig. 3, with pipes leading to the different oilers, cups or sight feeds. The used oil is drained into a tank under the floor, where some of the dirt taken up by the oil will settle and from

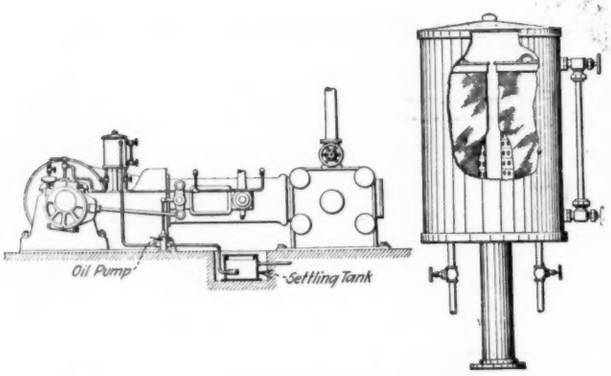


FIG. 3. OILING SYSTEM AND OIL RESERVOIR FOR SIMPLE ENGINE

which water carried along with the oil can run off into the sewer. A small pump driven from the rocker arm or some other convenient moving part forces the oil back into the tank, which should contain a strainer and a filter to separate out all impurities. All kinds of refinements and elaborations can be introduced in a system of this kind, they depend mainly on the amount of oil in circulation and on the degree of purity desirable in the used oil. The main thing is to keep the dirt away from the lubricated parts of the engine and prevent it coming in contact with the oil; the moving parts should, therefore, be protected and inclosed by dustproof oil shields. Since in a well-designed and carefully installed oiling system the loss is small, the oil should be fed to the bearings in a solid stream and to other parts, as the crosshead pin, the crankpin, the crosshead guides and the eccentrics, in large quantities without causing actual splash. Fine particles of oil are frequently carried to the floor or other places by air currents set up by the moving parts of the engine.

The filtration and purification of used oil is simple, and an engineer can rig up an apparatus himself without much expense. A large oil-storage can or even a good-sized galvanized iron ash can, about 20 in. in diameter by 30 in. high, with a cover, can be converted into a filter, as shown in Fig. 4. A pan of galvanized iron or tin plate is placed in the top of the can, supported by lugs riveted near the upper edge, and a ¾-in. malleable-iron pipe flange, curved to suit, is riveted on the side of the pan into which a nipple is screwed, which projects outside the can. To this a funnel is attached by means of an elbow for pouring the used oil into the pan; a strainer of fine wire mesh placed in the funnel will keep the coarser impurities from entering the pan. A 1¼-in. pipe flange, threaded from both sides, is riveted to the bottom of the pan, into which two pieces of pipe are screwed, the lower one to within about 3 in. from the bottom of the large can and the upper one to about the same distance from the top. The end of the lower pipe is threaded and a pipe flange screwed on with a circular perforated plate of tinned or galvanized iron resting on it. A perforated pan is set into the reservoir containing the used oil, the bottom and sides of this pan are covered with filtering cloth on the outside; the filter cloth may be muslin, felt, canvas or any other suitable woven material which will retain the fine impurities carried along with the oil. The oil to be filtered is poured through the funnel into the reservoir, which acts as a settling basin. In rising, it penetrates the filtering cloth and collects in the perforated pan, from which it descends through the central tube into the bottom of the can, which is partly filled with water. It spreads in a thin film over the bottom of the circular plate and rises through the perforations in drops to the surface of the water. In this way the oil is cut up into small particles, each of which is thoroughly washed in its ascent through the water. The purification process will be considerably improved if the water is heated. This can be effected by means of a steam coil placed either inside or outside near the bottom of the can. Suitable cocks must be provided for draining and for drawing off the filtered oil. The pans can be easily removed and cleaned and so can the filter cloth be cleaned or replaced by new material when necessary. There

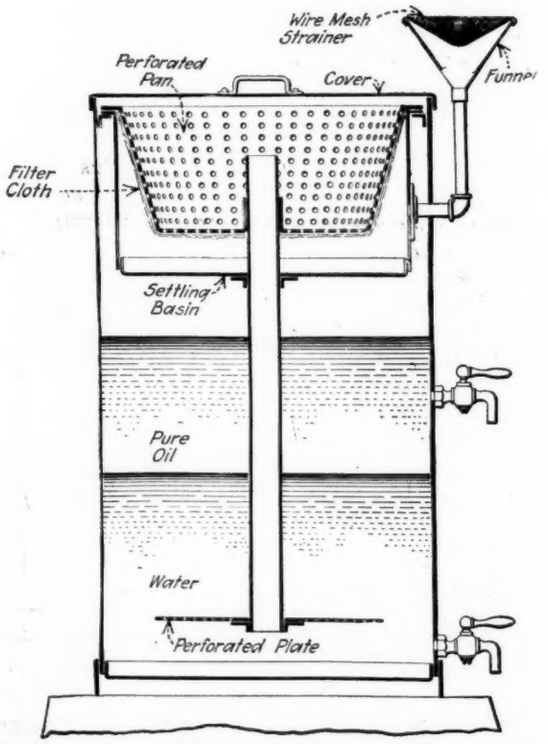


FIG. 4. AN OIL FILTER MADE OF MATERIALS FOUND ABOUT THE PLANT

are a number of efficient oil filters and purifiers manufactured, but the expense of installing one of them is sometimes the reason for not making any attempt to save the used oil. However, all used oil intended for use over again should be filtered.

Electric Motors for Driving Rubber-Mill Machinery

By WILLIAM H. EASTON
Industrial Engineer,
Westinghouse Electric and Manufacturing Company

ELECTRIC motor drive has been recognized as the most satisfactory for rubber-mill machinery ever since 1899, when the initial installation was made in the plant of the B. F. Goodrich Co. In fact, very few lineshaft-driven plants have been built during the last twenty years and most of the old plants that are still in existence have changed over to the motor drive. The special advantages of motor drive, as compared with older lineshaft-and-belt drive, are that it makes possible increased production, reduced expenses and improved working conditions.

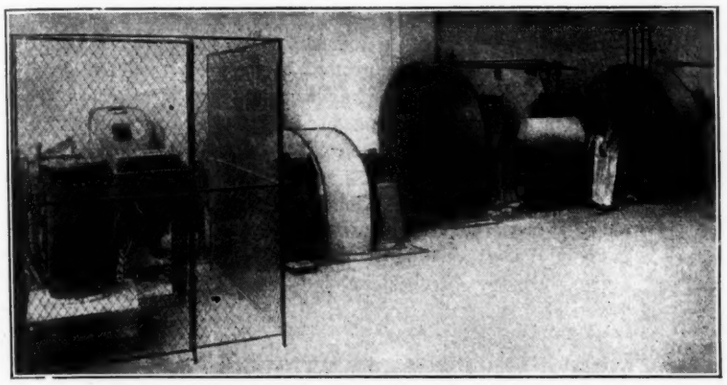


FIG. 1. HIGH-VOLTAGE 200-HP. WOUND-ROTOR MOTOR DRIVING MIXING MILLS. SCREENS INCLOSE THE HIGH-VOLTAGE EQUIPMENT

Advantages of motor drive are discussed and then the various types of motors applicable to rubber-mills are considered. Direct-current motors are entirely satisfactory, but in general the alternating-current types are preferred for a number of reasons.

The use of motor drive permits an increase in the efficiency of the plant as a whole. Each machine or mill-line is driven by its own individual motor and, being mechanically independent of all other machines, can be placed wherever desired. If two machines, similar in every respect, except that one is motor-driven and the other belted to a lineshaft, were to be operated side by side under similar conditions, the motor-driven machine would be found to produce more per day. The reason for this is that the speed of the motor-driven machine can be kept practically constant at its proper value at all times; whereas, with the belt-driven machine some variation in speed is bound to occur because of the slippage of the numerous belts between the machine and the driving power, and thus its average speed will be 2 or 3 per cent or even more below its proper speed.

The independence of motor-driven machines also helps to increase production by eliminating much of the time lost through the shutting down of departments, or the entire plant, when trouble occurs. Not only are the other machines unaffected when trouble occurs with a motor-driven machine, but since in most cases central-station power can be obtained for breakdown service, even trouble in the power house of the factory need not halt production.

The foregoing considerations apply to every machine in a rubber factory, but a special increase in the production of the calender can be obtained through the use of motor drive. When this machine is belt driven, only two speeds are available—a slow threading-in speed obtained by slipping the clutch, and a running speed. But for every grade and thickness of stock there is a very definite speed of the calender at which maximum production of the highest quality is obtained. If for a given grade of stock, the running speed of the calender is below this point, production is less than it should be; while if the running speed is too high, either the quality of the product suffers or the slow speed must be used which is ordinarily much too low for the most efficient results. When the calender is motor-driven, any desired speed range and any speeds within that range can be obtained. Each grade of stock can be run off at the most efficient speed (or very near it) and the full output of the calender obtained without increasing the cost of labor.

Though the reduction in expenses obtained through the use of motor drive is of small consequence when compared with the increase in production made possible, nevertheless it is of interest to note that an electrical drive system costs less to operate and maintain than a mechanical system. This is due to the fact that lineshafts must be given considerable attention in order to keep them in proper operating condition; the expense of belt renewals is high; and the

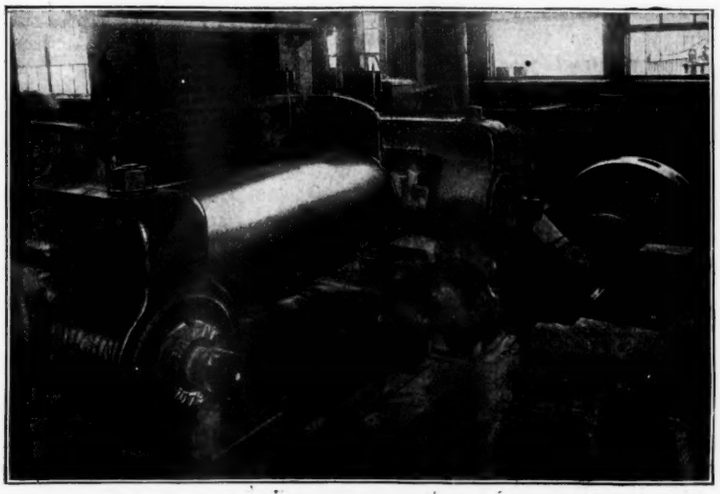


FIG. 2. MILL DRIVEN BY 200-HP. MOTOR

whole system consumes a considerable percentage of the power generated, especially when only part of the machines are in operation. Motors, on the other hand, especially where alternating-current machines are used, require little care; the power losses in the system are small; there is no loss at all for a machine that is shut down; and the depreciation charge is low.

A motor-driven factory is cleaner, lighter, better ventilated, and in every way a pleasanter place to work

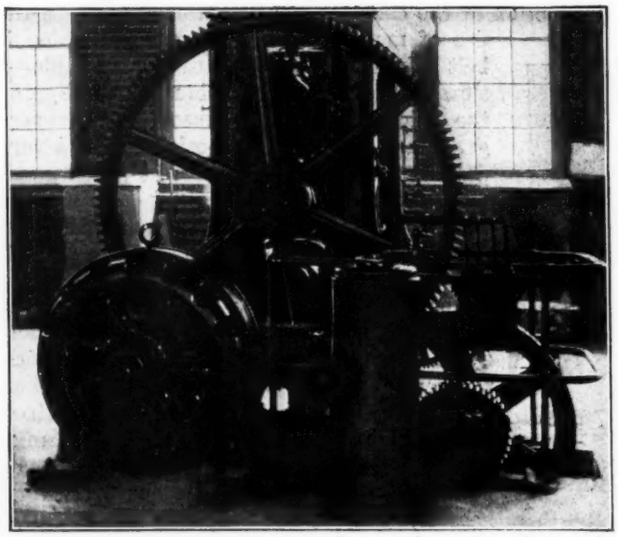


FIG. 3. CALENDER DRIVEN BY 75-HP. ALTERNATING-CURRENT MOTOR

in than one using belts and lineshafting. Motor drive is much safer, for the majority of the dangerous belts and pulleys are eliminated and the drives that remain, (whether belt, gear or coupling) can be readily protected by inclosing with screens. Safety stops can be placed at any desired number of points around the mills and calenders, so that these machines can be stopped instantly in case of accident; thus reducing these hazards to a minimum.

For driving the machinery direct current is entirely satisfactory, and several plants are using it for all power purposes. But alternating current is in general preferred for the following reasons:

Almost all of the machinery, with the exception of the calender and some minor machines, are of the constant-speed type, and alternating-current motors are especially well adapted for this service.

Alternating-current motors, having no commutators, require somewhat less attention than direct-current motors, especially in places where there is more or less dust.

If central-station power is used, alternating-current is almost invariably supplied; and if the factory has its own power plant, it is always good practice to generate the same kind of current as the local central station, in order to use power from the latter for breakdown service.

If the plant is large and the main-power circuits are several thousand feet long, alternating current is necessary in order to transmit power without excessive losses.

On the other hand, direct current must be used for calenders, if they are to have a wide range of speed, and in consequence the great majority of rubber factories use alternating current for their main power and generate an auxiliary supply of direct current for the calenders and some other adjustable-speed machines. There are, however, a few factories using alternating current throughout.

Motors for Mills, Crackers, and Washers

From the standpoint of motor drive, crackers, washers, and mills, all have the same requirements. They are all ponderous machines, require large motors (from 100 to 600 hp. depending on the size of the rolls and length of the line), operate continuously at constant speed and may occasionally (as on cold mornings) require a considerable excess of power for starting up.

The motor that is almost invariably used for driving these machines is the wound-rotor induction type, which is admirably adapted to this service because it can be made in large, slow-speed sizes, suitable for direct-connection to the mill; can be started gradually under a heavy load without drawing excessive current from the line; and operates continuously at a uniform speed at good efficiency. It is started by connecting its primary circuit to the line by means of an oil switch or circuit breaker, and bringing it up gradually to full speed by cutting out resistance in the secondary circuit by means of a drum controller.

Squirrel-cage motors have been used for mill drive, but to a very limited extent because their high starting current is usually objectionable.

Synchronous motors, on the other hand, appear to be growing in favor for this service, to which they are well adapted because of their slow speeds, high

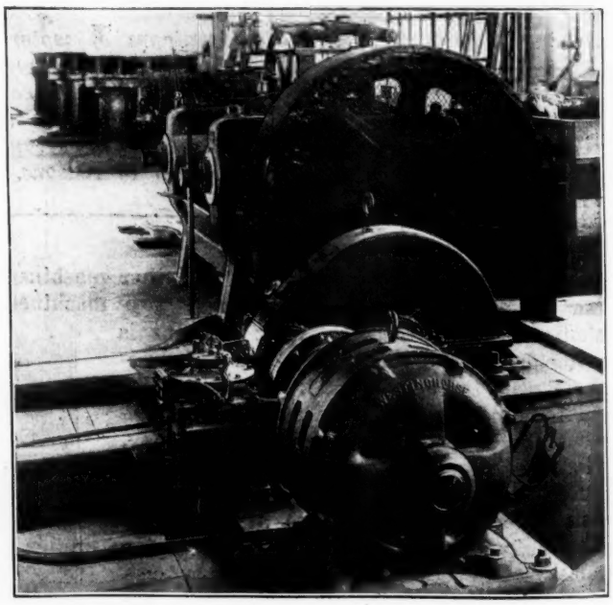


FIG. 4. CLUTCH AND BRAKE SHOWN BETWEEN MOTOR AND MILL

efficiency and ability to improve the power factor—a point of special importance when power is purchased. The difficulty in starting this type of motor under load is obviated by the use of the magnetic clutch, hereinafter described.

When direct-current motors are used for mill drive, they should be of the constant-speed compound-wound

type and controlled by automatic controllers, since manually operated controllers are not recommended for direct-current machines of this size.

Most mill motors are operated on circuits of 220 or 440 volts, but in a few cases where high-voltage alternating current is supplied to the factory, the cost of the transformer installation has been reduced by operating these large machines directly from the high-voltage lines. In such instances the motors and controllers must be protected with screens, as in Fig. 1, in order to keep unauthorized persons away.

The use of a magnetic clutch between the motor and the mill line is almost invariable practice. When this clutch is energized, it provides a rigid connection between the motor and the rolls; but when the clutch current is cut off, the motor is instantly disconnected and a brake is applied to the rolls, stopping them immediately. Switches, opening this circuit, can be placed in any desired locations around the rolls and

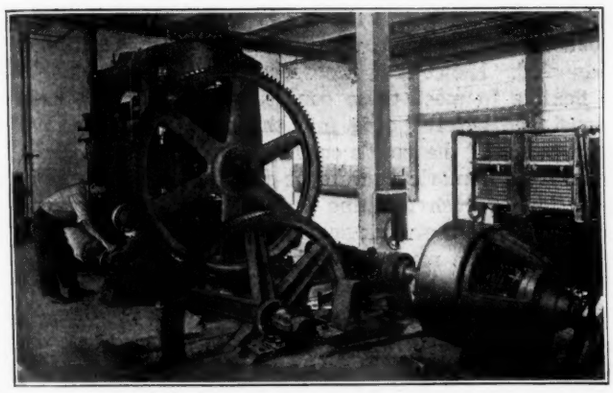


FIG. 5. DOUBLE-VOLTAGE 75-HP. DIRECT-CURRENT MOTOR DRIVING CALENDER

provide a high degree of safety. Direct current is needed to energize the clutch and, in alternating-current plants, is supplied by a motor-generator set. When sychronous motors are used for mill drive, they are brought up to speed with the clutch open.

Motors for Calender Drive

The wound-rotor induction motor, similar to that used for mill drive, can be used for driving calenders, Fig. 3, but its speed varies with the load, which is undesirable, and it provides a speed range of only from normal speed to 20 per cent below normal (the slow threading-in speed being provided mechanically). Its use is therefore restricted to calenders requiring but small speed variation. Direct-current motors, however, provide a wide speed range, and these are ordinarily used for calender drive.

Two kinds of direct-current drive have been specially developed for calenders:

1. The single-voltage system, in which the motor operates at all times on a 230-volt circuit. This is mainly used for small calenders.

2. The double-voltage system, in which a three-wire circuit is employed and the motor is operated on 115 volts for low speeds and 230 volts for high speeds. The main reason for developing this system is that by using two voltages a given horsepower and speed range can be obtained with a smaller and less expensive motor. It is mainly used for the larger calenders.

From an operating standpoint the two systems are practically alike, as the method of control is the same in both cases. The speed range of both motors is 1 to 4 (for example, 250 to 1,000 r.p.m.), with a number of steps, including a very slow threading-in speed.

The controller in general use is of the semi-automatic type and consists of three main parts: A small drum controller, called the master controller; a set of four push buttons, mounted on the calender and marked respectively "start," "stop," "slow" and "fast"; and a panel carrying a set of automatic magnetic switches.

The speed of the calender is regulated by the position of the master-switch handle. When this is on the first notch, the motor operates at its low threading-in speed, with resistance in series with the armature. On the second notch the armature resistance is cut out and the motor operates with full field strength and at its lowest running speed. On the remaining notches resistance is cut into the motor field in successive steps, so that the motor speed is increased until maximum is reached. With the two-voltage motor, Fig. 5, the connections are made with the 115-volt circuit for the lower speeds and with the 230-volt circuit for the higher speeds.

Moving the master-switch handle does not, however, start the calender. The handle is first set for the speed desired, and then, on pressing the "start" button, the calender starts and comes up to that speed. On pressing the "slow" button, the calender slows down to the first running speed, and on pressing the "fast" button it comes up to the speed corresponding with the setting of the controller handle. Pressing the "stop" button stops the motor and applies dynamic braking, bringing the rolls promptly to rest.

Neither the push buttons nor the master controller make the actual connections with the motor. These devices control the action of the magnetic switches, which in turn open and close the proper circuits and cause the motor to operate in accordance with the wishes of the attendant. Safety switches that stop the motor and apply dynamic braking can be placed around the calender in any desired number of locations.

In alternating-current plants, direct current is usually obtained by means of rotary converters or motor-generator sets. The former are generally preferred because they are more compact and efficient and less expensive. Both kinds of apparatus can be supplied with either a two- or a three-wire direct-current supply, depending upon whether the calender motor is single or double voltage.

Motors for Other Machines

Practically all other machines in the rubber factory are of the constant-speed type, and as, in general, they require small powers, they are usually best driven by squirrel-cage motors.

The machine tools in the repair shop and the ventilating fans are, however, preferably driven by direct-current motors to provide satisfactory speed variation. But these machines are usually relatively unimportant, and it is common practice to operate the machine tools by squirrel-cage motors, obtaining speed variation by mechanical means, and the ventilating fans by wound-rotor motors, which provide a fair degree of speed variation, or by squirrel-cage motors if speed control is unnecessary.

The Making of Better Producer Gas

Points of Interest in the Operation of a Large Gas-Producer Plant. Kind of Coal To Use, Tar Separation and Gasification in the Producer, Making Possible 200-B.t.u. Gas

By A. Clark Liscom
Engineer, Producer Gas Department, Ford Motor Company

THE planning, construction and operation of a producer-gas plant with an hourly capacity of two to five million feet, is one of the later developments for the economic use of fuel. With proper planning and operation, as high as 78 per cent efficiency can be maintained and the gas, cooled and cleaned, can be distributed through miles of pipe lines of ordinary size.

Producer-gas engines have an original cost per horsepower exceeding that of the steam engine, but this is counterbalanced by their higher economy in operation. Using this type of engine in conjunction with furnaces makes an excellent combination. The engines produced today will have a thermal efficiency approaching 30 per cent, and this economy is greatly improved by utilizing the heat from the exhaust gases.

Necessity of Good Ventilation

In laying out a producer plant the gas building should have liberal lighting from the sides and roof and be well ventilated, so that the men will not be obliged to leave the job on account of their lungs just about the time their training has made them of value on the work.

The building should not be used as a support for lean-to construction, thus shutting out ventilation and light. It should have ample area around the four sides for light and air, and interior passages should be laid out to permit moving the largest parts of the machinery without taking down walls or columns. A well-studied exhaust air system will be necessary. Injection of air into the building to dilute the mixtures is not the thing. The foul and heated air should be drawn out of the building quickly.

Proper Unit Arrangement

With their primary condensers or cooling towers and low-pressure or dirty gas headers, the producers should be grouped into units to the capacity of the exhausters, and the latter, with their driving mechanism, should be in a separate room. They will be cleaner and the bright work will have a chance. This does not mean that the producer room need be dirty if proper provisions have been made for coal and ash handling. Each exhauster taking the product of several producers should be capable of delivering the gas to either furnace or power mains, or both, as needed. On light loads a unit could be shut down for adjustment or repairs without affecting the balance of the load.

The exhausters should have a normal rating of 200 cu.ft. displacement or better. If the gas is used for both power and heat, there will be a difference in the line pressures. That of the power line will be between 2 and 6 in. of water, and the furnace line between 10 and 30 in. of water. The latter pressure will depend upon the length of the mains and the type of furnace used. The selection of large exhausters eliminates a row of small machines, each of which requires almost as much fuel, space, oil and attention as the larger outfit. The gas exhausters should never be installed without bypasses. When pumping dirty gas, the ends of the impellers should be lubricated with crude oil through force-feed devices.

Gas Meters Desirable

Coal- and ash-handling equipment require careful study. The size of coal most economical to use varies with conditions, but if the tar is to be returned to the producer and gasified, the finer sizes of slack cannot be burned. Hence it is necessary that the coal delivery be flexible to meet these conditions. The coal should be weighed before going into the producers. One per cent saving of the year's coal supply will buy the most elaborate automatic equipment for this purpose. The operation of each machine is then under close observation, so that the weak spots may be eliminated. The ashes should be removed with as little dust and labor as possible and should be sampled to check the wasted combustible. Ash weights should be available.

It is not desirable to locate distributing mains on the exterior of buildings in latitudes where the temperature is much below freezing in winter, particularly if laterals are to be connected. Producer gas is laden with moisture and distillation products. The change in velocity, and consequently in pressure, at a change in pipe size, causes precipitation of solids that will stop the flow of gas. It has been known to do this in less than ten minutes in passing from a 24-in. into an 8-in. pipe. Installation of heating apparatus at such points is uneconomical and the apparatus is subject to trouble. Gas mains should always be graded and provided with drains and cleanouts. Meters are essential to give the total fuel in and the total product delivered. If various departments are supplied, it may be advantageous to meter them separately. Rubber gaskets are not for producer-gas lines or machinery. Shellacked paper or cardboard will hold better than any other combination.

Planning the Tar Piping

Long lines for tarry water or tar drains should be avoided if they cannot be provided with intermediate clean-outs. In distinctly tar work, tees with a plug should be used instead of elbows. There will be many times when it is desired to find what is behind the plug without tearing down the line. There is a certain amount of tar work which cannot be eliminated. The proximity of tar operations to those of the cleaner sort should be avoided in the planning.

If the cooling water is not more than ordinarily cheap, it should be gathered at a common point, preferably a settling basin where the tar and dirt are precipitated, then put over cooling apparatus and recirculated. The water cost is reduced to the cost of handling and the makeup loss from evaporation. Many

types of pump are not adapted to the handling of tarry water. Preference should be given to pumps that are readily accessible for cleaning.

In a producer plant there are no smokestacks to spread soot and ash over the landscape and keep the smoke inspectors on the job, but there are times during the first and last parts of the stand-by periods when the escaping gas from the purge pipes is not much better; especially in the neighborhood of high buildings. As this gas is poisonous, the tops of the purge pipes should be provided with igniters and the gas burned.

The Need for a Laboratory

A well-equipped laboratory is a necessity. With such a laboratory it will be possible to know at all times the value of the fuel as fired, the quantity of wasted combustible in the ash and the character of the product from each unit. The samples for the regular record of the day's performance should be continuous over each shift. Snap samples for this work are valueless. Almost any gas man can put a machine in condition for a snap sample which will make a fine showing temporarily, but he may not be able to hold that condition for even one hour. One of the samples under such conditions ran 286 B.t.u. per cubic foot. The average for the eight-hour shift was 202. The laboratory will enable the raising of the hydrogen content of the gas to the limit, and will show when the return of tar has been properly handled to give the maximum quality of methane.

Stand-By Loss Is Small

The comparative ease with which good economy can be effected in the producer makes this method of generating heat value attractive. The loss of fuel during the stand-by period is particularly low. Producer gas is formed by slow combustion, which is not brought to completion in the producer, the final burning being done in the engines and furnaces. To obtain a high B.t.u. value uniformly, that does not necessitate juggling with the mixtures of air and gas at the engines and furnaces throughout the working period, pick the best fuel possible, stick to it, and keep the fuel uniform.

Use Good Coal Uniform In Size

The B.t.u. value and the ash content of the coal have much to do with the final cost of the gas. Compare two coals, one having a value of 14,400 B.t.u. and the other 11,000 B.t.u. per pound. If the delivered price of the first was $8 per ton, the price for the other should be $5.53, based on heat value. The high-heat-value coal will probably have 6 per cent ash, while the poorer qualities will have, say, 12 to 14 per cent. Taking the low figure, the additional ash is 6 per cent. If the plant uses 7,000 tons per month, this additional ash amounts to 420 tons at $8, or $3,360. If the gasification cost per ton is $3.50, add $1,470, and if the ash disposal costs 50c. per ton, add $210, giving a total of $5,040 for excess ash. It has used up room in the car en route and in the producers which could have been occupied by good fuel. Of the better coal a horsepower-hour would be produced from ¾ lb., and of the low grade the same amount of work will require almost a pound.

Another feature affecting economy is the size of the coal. Gas producers have a large grate area and a deep fuel bed. For anything like effective gasification, the draft throughout the bed must be uniform. Coal with large quantities of slack content cannot meet this requirement. At intervals the draft is greater where the coarser coal happens to lie. This is fatal to efficiency. The coal should be nearly uniform as to size so that the voids will have the same character. The deep fuel bed allows a higher velocity of the passing gases, which means a greater quantity of gas from the same floor space. The same time element of contact is maintained between saturated air and the incandescent carbon as with a thinner fuel bed and a lower gas velocity. In addition the deep fuel bed has a thermal flywheel effect that will be found useful on fluctuating loads.

Gasification of the Tar

When the tar is returned to the producers, slack coal is an obstacle of serious dimensions. In the later types of clean gas plants all cooling and drain waters are carried to a settling basin where the tar is precipitated with such solid matter as is washed from the gas. The tar is pumped back to the producers and sprayed over the fuel bed. A small quantity of steam assists in the distribution at this point. Standard duplex pumps with iron fittings are used to return the tar. If the fuel bed is composed of sizes above "pea," the tar will be uniformly distributed over each piece of coal without choking the voids, and as it settles to the distilling zone it is driven off in the form of methane. If the bed consists of considerable slack of fine size, the addition of the tar makes a pasty mass that will check the draft, and the result, due to the general disruption of the bed conditions, is poor gas.

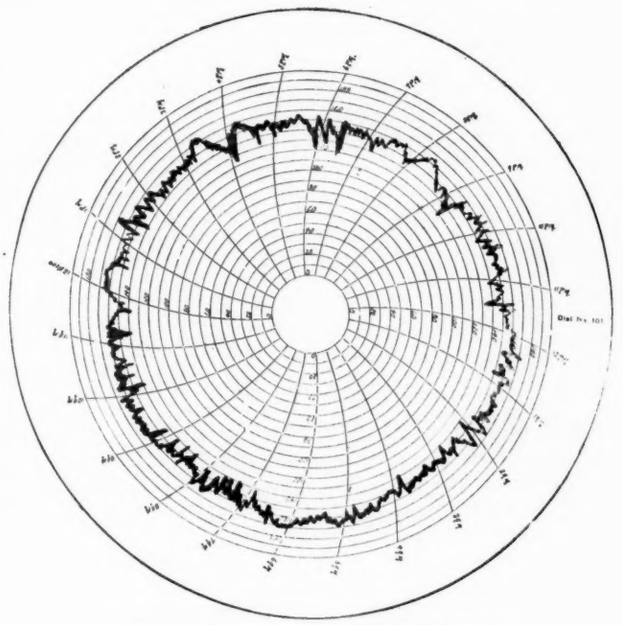


FIG. 1. TYPICAL CALORIMETER CHART
Poor coal, heavy load off at 12 p.m. and on at 6:30 a.m. Each quick drop entails much excess labor to get back to normal.

As nearly 10 per cent of the coal is tar, it is quite necessary that its heat value be utilized. Gas without tar return should, if conditions are good, analyze: CO_2, 5 per cent; CO, 25 per cent; H_2, 17.5 per cent; CH_4, 3.5 per cent; C_2H_2, 0.4 per cent, and N_2, 48.6 per cent. The B.t.u. value is 189 and the percentage of combustible, 46.4 per cent. With the same fuel con-

ditions and the return of the tar, the analysis will show CO_2, 5 per cent; CO, 24.5 per cent; H_2, 17 per cent; CH_4, 5.5 per cent; C_2H_4, 0.5 per cent, and N_2, 47.5 per cent. The B.t.u. value is 208 and the percentage of combustible, 47.5 per cent. This is conservative. If the conditions are maintained for several days, the CH_4 may go as high as 8 per cent. The samples, taken from continuous eight-hour sampling tanks, were chemically analyzed and computed and checked with a calorimeter. These results cannot be obtained from coal containing slack in any quantity. The place for slack is under boilers. Likewise the place for coking coal is in a coke oven, not a gas producer.

Avoid the Finer Sizes of Coal

If it is attempted to use the finer sizes, the thickness of the fuel bed must be cut down so that the mass will "breathe." About the time this condition is attained, little channels are blown through the fire bed. Oxygen,

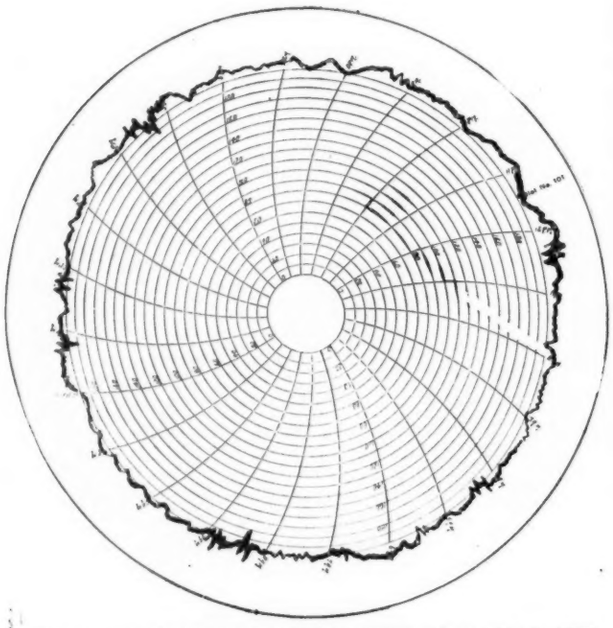


FIG. 2. CALORIMETER CHART WITH GOOD COAL AND CAREFUL OPERATION

The quick fluctuations, generally right after shift changes, are due to violent grate shaking.

unchanged, comes through and, in contact with the hot gas, burns a proportional amount of the gas to CO_2, with a consequent reduction in quality. Then the vapor is filled with fine solid matter known as lampblack. The offtake temperatures rise from 800 to 1300 deg. or higher. The tops of the producers suffer from the heat as well as do the men. Larger quantities of water are necessary to cool the gas. The exhausters are putting out 160-B.t.u. gas instead of 200, and it costs just as much to pump a cubic foot of the leaner gas. Other costs increase in proportion. There is but one proper course in this case, and that is to reduce the velocity through the fuel bed, and this means less gas from the same installation.

A résumé of the fuel situation shows that the coal should have a high heat value, be uniform as to size, low in ash content and non-coking. It should have less than 1 per cent of sulphur, and the fusing point of the ash should be high. The most desirable size is re-screened nut, but this has little commercial value over a coal passed through a 4-in. screen and over a ¾-i screen. The sulphur content should be low, as it d stroys contact parts of the power apparatus under hi heat and moisture. For furnace work a high sulphu content attacks metal, in some cases making the g unusable and at all times a hardship for the furna workers. Clinkers can be mastered usually by addi moisture to the air supplied under the grates of t producer.

Removing the Tar from the Gas

There has been much improvement in the cleaning of producer gas. The tar-laden gases were formerly passed through an incandescent coke bed. The smothering of the incandescent mass by the gas was to be overcome by the addition of air. The air did not stick to the coke at all times, but united with the incoming gas and burned it. The electric ionizer was another stage in the development of gas cleaners. A two years' fight with this under the writer's supervision resulted in getting the solid matter down to 0.08 gram per cubic foot. This was productive of a dirty mess in the engines and the furnace line valves. City gas had to be admitted around the electric insulators. The temperature of the gas had to be juggled with changes of fuel. The outfit finally went to the scrap heap with its predecessors. Down-draft machines have been successful to a certain extent in small plants, but not where the operation has a gap of but eight hours per week for clean-up and often not even that.

A later claimant for honors in this line is the spun-glass screen. This is not in effect a mechanical screen, for the tar is agglomerated and precipitated after passing through the screen. When the fuel is poor and the operation is defective, lampblack is held up on the pressure side of the screen and the pressure necessary to force the gas through the cleaners rises rapidly until it is a hardship to handle the output. With experience the operating end of the trouble soon disappears. As low as 0.0025 gram of solid matter per cubic foot of gas is fast becoming past history, as much of the time this low figure has been improved.

Two Hundred B.t.u. Gas

Reference to the various authorities now available shows that 160 B.t.u. is the best average quoted for a cubic foot of producer gas. The reason for this seems to be that the rough and ready methods of the old dirty, hot gas plants have left their impression on the industry. In larger plants, where more intensive study is made of the work, this figure is low. With the larger types of machines fed with two to three tons of good coal per hour, the offtake temperatures will not go much above 800 deg., the cooling-water requirements will be nominal, and the machines will last several years without internal repairs. Some machines have been run for eighteen months without letting the fires go out, even when the coal has not been kept to the specifications given previously in this article. When good conditions obtain, there is almost absolute control of the balancing of the gas values. The proper proportion of CO, H_2 and CH_4 can be maintained. It has been found that for some engines a hydrogen content of more than 18 per cent produces preignition, while for furnace work all that can be made adds to the value of the gas. The latter is especially pertinent for small flames.

In the table are given analyses of random eight-hour samples taken when good operating conditions were maintained. All are from machines using 1¾ to 3 tons per hour. The samples were chemically analyzed and computed and checked with the calorimeter. The tar was being returned in all cases.

ANALYSES OF RANDOM EIGHT-HOUR SAMPLES

CO_2	CO	H_2	CH_4	N_2	Comb.	Inert	B.t.u.
3.9	27.1	16.6	5.5	46.9	49.2	50.8	209
8.3	21.3	20.3	5.2	44.9	46.8	53.2	198
7.5	22.1	19.7	5.2	25.5	47.0	53.0	199
3.9	26.9	17.5	4.6	47.1	49.0	51.0	202
7.5	21.7	17.6	6.1	47.1	45.4	54.6	200
3.8	26.9	16.0	5.5	47.8	48.4	51.6	206
5.4	25.0	16.3	5.6	47.7	46.9	53.1	202
4.0	25.9	17.7	5.6	46.8	49.2	50.8	210
9.5	19.5	21.4	6.6	43.0	47.5	52.5	211

In the tabulation the C_2H_4 is grouped with CH_4. Excess steam produced high H_2 and CO_2 and lower CO, but the total is supported by extra H_2 and CH_4, so that the final heat value of 200 B.t.u. is not much affected. In 1918 a freak eight-hour sample for which no tangible clue has ever seemed logical, ran as follows: CO_2, 15 per cent; CO, 14.9 per cent; H_2, 33.6 per cent; CH_4, 9.3 per cent; N_2, 27.2 per cent; combustible, 57.8 per cent; inerts, 42.2 per cent; B.t.u., 266. No sample since has approached this heat value nearer than 227 B.t.u.

With the conditions previously enumerated, the production of 200-B.t.u. producer gas can be considered standard, and the cost of the gas delivered in the mains at the furnaces and engines should not exceed $3.50 to $3.75 per ton of coal, supplying, say, 110,000 cu.ft. Another year will see the general adoption of ammonia recovery in large plants, and this will help to reduce the cost for fuel. It is feasible to use clean 200-B.t.u. gas for city distribution, since gas lighting is now a negligible quantity, and also for various industrial purposes, including heat treating, drop forging, tempering, bath work, enameling, soldering, etc.

Electric Welding Machines—Factors Influencing Their Operation

By L. W. WEBB
Master Electrician, United States Navy Yard, Norfolk, Virginia

Various types of welding machines have characteristics common to all. A machine should not be chosen from the standpoint of power input to power delivered at the arc alone—amount of work produced should be one of the deciding factors. Variable reactance should be used in all welding circuits. A curve is given showing the amount of reactance required in a welding circuit for different values of current.

ALL THE different types of constant-potential and constant-current welding machines, described in the Aug. 10 and 17 issues, possess features common to each but each one has some individual characteristic peculiar to itself and which, the manufacturer claims, possesses certain advantages over the others. Some of these machines have been designed to be of the slowspeed, three- or four-bearing, continuous-duty type with rugged frames and commutators, which would insure long life and reliability; while others have been designed for high speed, of the two-bearing type with a rating for normal load of one hour, and are as small and compact as possible, which makes them lighter and more easily portable than some of the others.

Both of these types possess advantages and disadvantages, depending more upon local conditions as to their use than any real merits or demerits in the individual machines themselves. Some of them have motors that show small percentages of drop in speed from no load to full load, which is a desirable feature and assists greatly in making the welding operation more stable at the instant of striking the arc. Other types allow greater drop in speed between no load and full load and depend upon supplying reactance of higher value to care for this drop in speed at the instant the arc is struck.

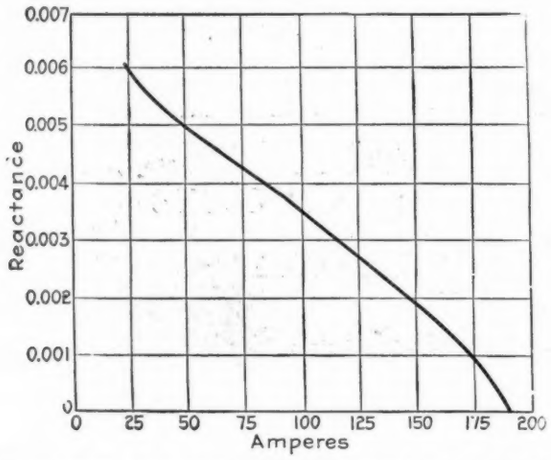
The efficiency of the various machines ranges from about 50 to 65 per cent. The over-all efficiency depends somewhat upon the manner in which it is calculated and whether the machines are designed on a continuous-duty cycle or on one-hour rating. These efficiency assumptions are made strictly from the input and output standpoint and do not consider any losses in the external circuit, which, in some of the machines supplying reactance having high values, amounts to considerable.

The fact that one machine is more efficient than another from the standpoint of power input to power delivered to the arc, however, is not of the greatest material advantage after due consideration is given to the fact that the pay of the operator is usually many times that of the cost of power and the value of the work produced is much more than both combined. The machine that is capable of producing 5 to 10 per cent more work than another machine, even though it had an efficiency of 20 per cent less, might, from the standpoint of cost of work produced be much more economical to use. One of the determining factors in deciding upon the general adaptibility of any type of machine should be work produced rather than efficiency from the power-consumption standpoint.

It is desirable at all times to have machines that are efficient but require very little maintenance; that are reliable in operation and simple to operate; that can be depended upon at all times not to break down or heat up excessively under abnormal conditions of rush jobs, etc; and that are easy for ordinary operators to use. Machines having these characteristics would in most instances be preferable to others that might be far more efficient and that could be purchased at less cost than these.

For this reason in general it is usually just as efficient to do welding with machines of the 60-volt constant-potential type as with those of the so-called constant-current type, as experience shows that with these higher voltages the operator can, in the course of a day's work, usually produce more work than with the other type

of machine. This is especially true where several operators are grouped in close proximity and can be supplied from multiple-operator type constant-potential 60-volt machines, and in such a case not only is the maintenance of the whole equipment lessened, but the time saved in starting and stopping welding operations amounts to considerable. Where machines have to be portable, most of those of the constant-potential type on the market are necessarily of higher rating than those of the constant-current types, and are therefore much heavier; but one machine in particular is an exception to this, and this one is very compact and weighs less than most of the



REACTANCE AND CURRENT FOR SUITABLE WELDING CONDITIONS

constant-current types of motor-generators. As the efficiency of this machine is very much higher than that of many of the constant-current types, its over-all welding efficiency is not very much lower when compared from power input to power delivered to the arc standpoint. This type of machine will produce as much or more work in the course of a day than some of the so-called constant-current types.

Efficiency Not Governing Factor

Therefore, while in the descriptions of the individual machines in the previous articles, mention was made of the fact that some showed a higher over-all efficiency than others, and also the fact that the constant-current type of machine is more efficient than the constant-potential type from the standpoint of power input to power delivered to the arc, and while the manufacturers themselves lay great stress on these efficiency values, they alone should not be considered from an economical standpoint of cost of total work produced.

In each of the descriptions of the machines it was noted that certain reactances—usually connected in the external circuit, some of them partly variable but usually of the fixed type—were furnished with each machine and the amount of reactance on the individual machine varied considerably.

As can be clearly recognized, each type of machine has common to itself certain definite machine reactance due to its series field windings, etc. This would seem to indicate that external reactances provided with them were of such values that the sum of the two reactances would make a certain definite total reactance in each welding circuit, for the best conditions of arc stability and ease on the operator. However, most of the manufacturers have neglected this to a certain degree, possibly due to the rush in getting out designs or standardizing their sets. Some manufacturers supply reactance of high values so that any operator, even though inexperienced, can maintain an arc and do welding with the machine without any special instructions; other manufacturers have provided only the amount of reactance that should be required by an experienced operator holding the proper arc length, and which, if the arc were drawn out too long, would cause it to blow out. The latter point is an excellent one from the standpoint of preventing poor welding due to an inexperienced operator holding too long an arc. It keeps him strictly on the job at all times and makes him maintain the proper arc length and prevents him from becoming careless. Experienced operators, however, do not have this trouble, as they are not likely to get careless and allow the arc to be drawn out too long.

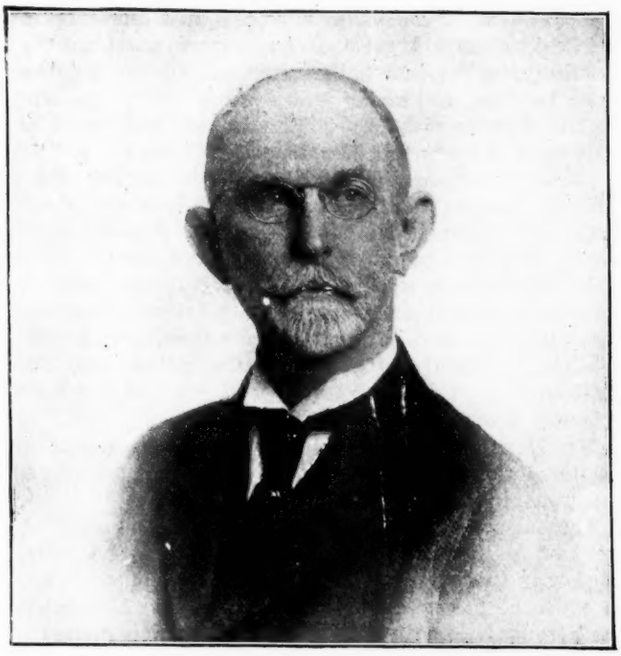
The correct amount of reactance is such that when the arc is lengthened out beyond a point where poor welds would be made, self-regulation of the machine should be such that the arc is immediately blown out. Also, it can be easily seen that for best results this reactance must vary with the current used and the nature of the weld. A variable type of reactance for best welding should be provided with each machine, rather than the fixed type, as is at present furnished by most of the manufacturers. Even though this adds materially to the cost of the machine, it is justified by the better results that should be obtained in the welding itself.

Tests Made to Determine Reactance Required

To obtain a general idea of how the reactance required varies with different current values used, a storage battery delivering about 600 amperes at 60 volts for one hour, continuous rating, was connected through a non-inductive resistance and a variable reactance to a welding circuit. By varying the reactance to get suitable welding conditions for currents from 60 to 200 amperes, the curve plotted in the figure with currents as abscissas and reactance as ordinates was obtained.

All wiring was run in duplex wire with straight leads to eliminate all circuit reactance, consequently the variable reactance would then be total in each case. It was noticed that from 60 to 100 amperes the reactance required was easy to ascertain, and from 125 to 150 amperes more difficult; from 150 to 200 amperes no perceptible difference could be noticed with all reactance cut out. This was particularly noticeable and indicates that the lower currents do not have arc stability and require stiffening much more than the higher currents. These results were obtained by close observation and using the most experienced operator available. He was not allowed to know when the reactances were varied or whether higher or lower values added. Three or four checks were made before the final value was determined upon. It is believed that much more accurate results could be obtained by the use of an oscillograph, but as no apparatus was available it was done in the manner described. Also, as the voltage was reduced from 60, more reactance was required, and the more stable the voltage the less the reactance. Therefore machines that are slow to regulate should have higher reactances than those which regulate quickly. Also, the more stable the circuit voltage and the machine speed, the easier it is to weld with less reactance. In every case, however, the reactance should be variable for different currents used within the range of the machine.

Francis Winthrop Dean



Since Leaving College Two-Score Years Ago, Mr. Dean Has Given Much Time and Thought to Improving the Design of Boilers, Steam Engines, Pumping Machinery, etc. Many Important Modifications in Construction and Operation Are the Results of His Efforts.

DURING the world conflict in 1917 the United States was faced with the tremendous task of quickly transporting overseas to the scene of the struggle millions of men and vast quantities of food, clothing and ammunition. The task was seemingly impossible, and even the Germans ridiculed the idea of a nation three thousand miles away being an effective opponent. There were not nearly enough ships to transport troops and supplies in the quantity needed. The United States Shipping Board Emergency Fleet Corporation was formed to consider ways and means of facilitating the construction of the much-needed ships. Not the least important part of this task was the design of an efficient boiler for use in wooden vessels. F. W. Dean, who for a decade had been interested in improving the design and construction of boilers and who had done much good work in this direction, was selected to take direct charge of a series of tests to determine on a standardized boiler for use in the wooden ships which the United States Shipping Board was planning to construct in great numbers. Both coal and oil were used in the tests. A number of modifications in the design of boilers were suggested by Mr. Dean, which were adopted as standard. This work did not end with the war, but formed the basis of further investigation and improvement.

The outstanding characteristics of Mr. Dean are painstaking care and conscientiousness in his work. The performance of these boilers furnishes ample proof of the ability of the man who designed them.

His work, however, was not confined to boiler tests. A number of experiments with steam engines were conducted, and at present he is testing out an experimental uniflow engine with the object in view of obtaining data on the performance under varying conditions of this type of engine.

Mr. Dean was born in Taunton, Mass., in 1852. After completing his primary education at that place, he entered the Lawrence Scientific School where he studied civil engineering. In 1874 he became an instructor of civil engineering in the Lawrence Scientific School. He resigned in 1882 and entered the office of E. D. Leavitt, Cambridge, Mass., as an assistant. Later, he became a draftsman, inspector of machinery and chief draftsman, which position he held from 1886 to 1889. Mr. Leavitt, his employer, had the reputation of being one of the most conscientious and expert engineers on the design of mining machinery and pumping engines in the country. At all times he sacrificed economy for perfection of construction. Mr. Dean received valuable experience here and became so appreciative of the engineering ability of his employer that he wrote a review of his work. In 1889 he opened an office in Boston as the head of the firm of Dean & Main, engineers and architects. While a member of this firm he had as clients a number of large manufacturers, including the American Woolen Co., the Lowney Chocolate Co. and the Walter Baker & Co., Ltd., of Dorchester, Mass., and Canada.

He also designed the power plant of the Massachusetts General Hospital at Boston.

Mr. Dean's interests at this time were varied, and much research work was done by him on the design of boilers, pumping machinery, utilization of pulverized fuel, compound engines, etc.

In connection with his pumping-machinery tests in 1894, he prepared the design for a new suction system for the City of Taunton. During the same year he was retained as expert for the Louisville Water Co., Louisville, Ky. With Dexter Brackett, expert for the I. P. Morris Co., of Philadelphia, the builders of a new pumping engine at Louisville, a contract trial of six days' duration was held. The engine ran 144 hours and 10 minutes without a stop, the longest test run then on record, and established itself as the most economical compound engine that had been tested up to that time. A short time later he conducted an experiment

with a compound engine working with high-pressure steam with the idea of establishing the economy of performance of an engine of this character.

For several years prior to 1915 Mr. Dean had been impressed with the value of corrugated furnaces for vertical boilers. A great deal of experimental work on the design of fire-tube boilers and steam drums has been done by him, embracing every phase of construction, and in a paper presented at the annual meeting of the American Society of Mechanical Engineers in 1915, he brought out very clearly the need for care in detail of construction and pointed out various remediable faults of boilers. He also suggested changes which would eliminate many of the prevalent faults.

No matter how efficient the boiler or engine may be, maximum performance cannot be obtained unless the best fuel is used. Mr. Dean is now turning to pulverized coal as the ideal fuel. He is firm in his belief that this method of burning coal when carried out on a scientific basis will give the best results.

Mr. Dean, while modest and unassuming, has never hesitated to give the benefit of his wide experience to fellow engineers.

The following papers presented to the American Society of Mechanical Engineers indicate subjects which have been in direct line with his professional work and in which he has specialized: "Distribution of Steam in the Strong Locomotive"; "Some Experiments with the Throttling Calorimeter"; "Trials of a Recent Compound Engine with a Cylinder Ratio of 7 to 1"; "Trial of the Leavitt Pumping Engine at Louisville, Ky."; "Report of Committee on Standard Method of Conducting Duty Trials of Pumping Engines"; "Power Plant of the Massachusetts General Hospital, Boston, Mass."; "Forcing Capacity of Fire-Tube Boilers"; "Comparative Tests of Steam Boilers with Different Kinds of Coal"; "Calorific Power of Weathered Coals"; "Burning Anthracite Culm"; "Best Form of Longitudinal Joint for Boilers."

He is a member of the American Society of Mechanical Engineers (vice president, 1895-7), Boston Society of Civil Engineers (vice president, 1907-9), N. E. Water Works Association, Engineers' Club, New York; Harvard Union, Cambridge, and Exchange, Boston.

Mr. Dean is an ardent lover of music and manages occasionally to steal away from the cares of business to attend concerts and recitals.

"Type A" Power-Plant Oil Filter

On oil filter that should interest power-plant engineers is manufactured by the Richardson-Phenix Co., Milwaukee. This filter operates on the so-called dry principle of filtration, in which the oil is not passed through water. It is designed to accomplish purification both by precipitation and by filtration through closely woven cloth. By the former process the oil is brought practically to rest, and entrained water and heavy particles of foreign matter are allowed to settle out. The incoming dirty water is heated to lower its viscosity and reduce its ability to retain water and foreign particles in suspension. The oil then takes a long path, flowing at low velocity over shallow trays where precipitation takes place, and finally through the filtering medium. The oil is stored in a clean-oil compartment ready for re-use. When necessary, it is passed over cooling coils after being filtered.

Referring to Fig. 1, the dirty oil enters the filter through the removable strainer box *A*, where large particles of foreign matter, such as waste, etc., are removed. It then passes to the heating tray *B*, where its viscosity is so reduced that it becomes extremely thin and is unable to retain the water and solid matter in suspension. The heating tray is so arranged that the oil flows over the heating coil *C* in a thin stream.

After passing over the heating tray, the oil flows through compartment *D* and down through the funnel *E*. Passing down through the conductor *F*, it is spread out by the baffle *G*. Under the action of the greater head that can build up in the conductor *F*, the oil is forced to take a zigzag course upward, passing under the trays, *H*, *I*, *J* and *K*, as shown by the lines of flow, and out through *R* to the filtering compartment.

As the oil passes over the tray at a very low velocity ($\frac{1}{10}$ ft. per minute at the normal capacity of the filter) the heavy particles of dirt and water settle to the bottom of these trays; and as the water, in settling, takes a course at a right angle to the direction of the flow of the oil, the movement of the latter offers no resistance to the precipitation process.

The separated water collects in the bottom of the trays and is bypassed directly to the bottom of the precipitation compartment by means of the funnels *L*, *M*, *N*, and *O*, and does not come in contact with the oil where it might be picked up again. The water in the bottom of the precipitating compartment is automatically ejected by the adjustable water-overflow tube *P*. The column of water in the pipe balances the column in the precipitation compartment, which is made up largely of oil and partly of water. As oil is lighter

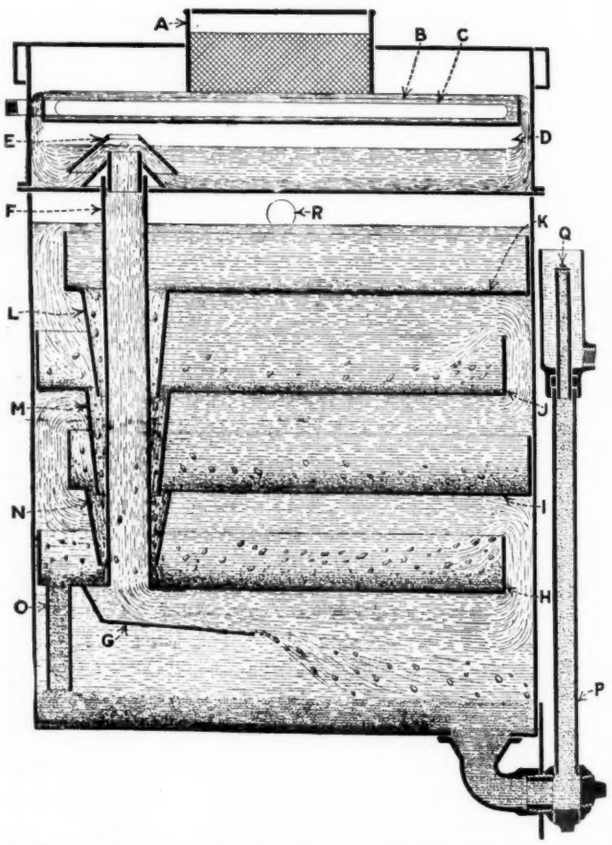


FIG. 1. SECTION THROUGH PRECIPITATION COMPARTMENT AND AUTOMATIC WATER EJECTOR

than water, the top of the tube *Q* is a little lower than the overflow level of oil in the precipitating compartment, the overflow is always water sealed and can be so adjusted that oil will not pass out through it.

The level in the top tray is maintained constant by a skimmer, *R*, Fig. 2. The oil then flows through the pipe *S* into the filtering compartment, which contains nine

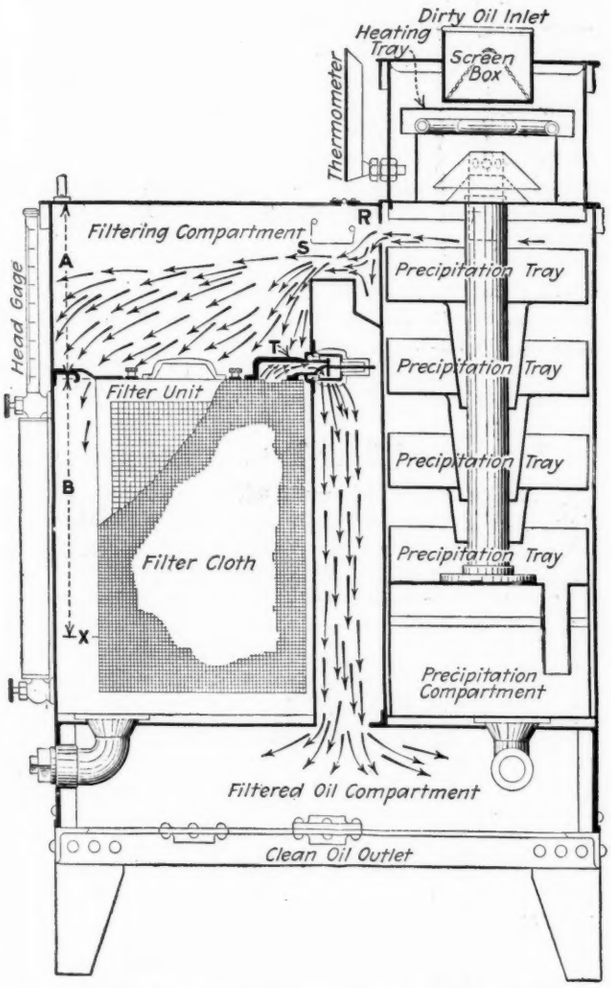


FIG. 2. SECTION THROUGH FILTER, SHOWING FILTERING COMPARTMENT

non-collapsible filtering units, passing from the outside to the inside and then out through the nozzle *T*.

The clean oil occupies all the space in the bottom of the filter under the precipitation and filtration compartments and also the space alongside the filtering compartment, which is about one-half the width of the filter. The clean oil is piped off through a fitting in the center of the bottom of the filter.

Simple Rules for Operating Hand-Fired Boilers When Using Low B.t.u. Coal

By W. A. Darter

The thickness of the fuel bed should depend upon the nature of the fuel, whether lumpy or slack, hard or soft, also upon the draft, whether weak or strong. If the draft is strong, a thick fuel bed can be carried, because the air can be forced through the fuel. If a thick bed of slack coal is carried, air cannot easily pass through it, hence a thin fire or fuel bed is necessary.

With a given load on a boiler a given amount of coal has to be burned, and this amount of coal will require a given thickness of fuel bed and therefore a given draft.

To get the best results from the fuel, it is necessary to keep the grates free from ashes and clinkers, because they keep the air from entering the fuel bed, and without air the coal cannot burn.

With very slack coal keep the fuel bed about three inches thick. The more lumpy the coal the thicker the fuel bed can be kept. With forced draft and thin fuel beds air holes will form and give an excess of air. Thick fuel beds have a tendency to form clinkers and give trouble. Keep the fuel bed level and all the holes filled up.

Stoking and Firing

It is better to systematically stoke the furnace at short intervals than to fire it at long intervals. The intervals depend upon the load the boiler is carrying. If lightly loaded, the intervals can be longer. While firing, do not keep the furnace doors open any longer than necessary, because cold air rushes in and chills the boiler.

Only a part of the furnace should be fired at one time, because if coal is thrown over the entire grate surface there is an interval in which the steam pressure will drop and then rise. This change in pressure is not desirable and is wasteful of fuel.

The grates should be shaken just enough to get rid of the ashes, but not enough to shake coal through into the ashpit. The fires should not be stoked any more than it is necessary, because stoking causes clinkers —the melting of ashes together.

All coal burned should be weighed and the water metered, in order to figure the evaporation. Watch the draft gages to see that the boiler does not have too much draft for the load. With the damper set at the right position, the draft gages will show when the fire has holes in it or when the fire is choked.

Blowing Down Boilers

The interval at which boilers are to be blown down depends on the nature of the water that is used. Very hard water containing vegetable matter will require more blowing down than water that is free from such matter. With good water, blow down the boilers about one inch every twenty-four hours; with poor feed water, blow down from two to three inches every eight hours. The water column should be blown down on every shift to make sure that the water level in the boilers shows true. Don't open or close blowdown valves with a jerk, but open them wide.

The soot on the tubes should be blown out at least every shift, when the boiler is carrying full load, and the blowing should be done with high steam pressure.

Control of the Draft

The draft can be controlled in two ways—by operating the damper and by closing the ashpit doors. When too much draft is used for the thickness of fuel bed or the coal used, then an excess of air is used, which is the greatest enemy to proper combustion of coal. The better way is to control the draft by the damper and not by the ashpit doors. Controlling the draft by the ashpit doors causes a greater suction on the entire

boiler setting, and all cracks and porous bricks will admit more cold air, thereby reducing the efficiency of the boiler.

The damper should be kept as nearly closed as possible and still keep up the required steam pressure. The required position of the damper for every load should be tested out and marked.

The less draft with which a boiler can be operated without giving out smoke, the better will be the efficiency. The CO_2 machine should not, ordinarily record over 12 per cent. Excess air will reduce the percentage of CO_2. The greater the amount of damper opening, the greater the amount of heat that will go up the chimney.

When using dumping grates, clean one section at a time and try to clean the fire when the steam pressure is normal or above normal and when plenty of water is in the boiler.

To clean one section, push the fire to the back end of the section to be cleaned, dump the front half of the grate and pull out all the large clinkers. Then pull all the fire to the front of the section and dump the back half of the section, and rake out all the clinkers. Then distribute the fire evenly over the section and cover with coal.

After the steam has reached normal, clean the other section and so on until the entire grate is cleaned. To clean stationary grates, push the good fire from one side toward the center of the boiler and rake out the ashes and clinkers. Then distribute the fire evenly over the clean section and cover with coal. After the steam is again normal, clean the other side and so on until the entire grate has been cleaned. Never clean the whole grate at one time because the boiler will become chilled and there is always danger of the steam pressure dropping. When a boiler is running heavily loaded, the fires should be cleaned about every three hours.

To remove ashes by hand with the least heat, always throw sufficient water on them to kill the live fire. If more water than this is used, it makes the ashes water-soaked and hence heavier to handle.

Live ashes should not be dumped near wooden structures or any material that is likely to catch fire. Before removing ashes from the ashpit the fire should be thoroughly cleaned and all clinkers pulled.

Banking Fires—Method No. 1

Push the fire back to the bridge wall and cover it with green coal and then with some ashes if needed. Close the furnace tight.

When the boiler is needed, spread the fire evenly over the grate and add coal. When a boiler remains idle only a part of a day, it is best to bank the fire, because the walls and boiler retain their heat and a great amount of contraction and expansion is avoided.

Banking Fires—Method No. 2

To bank a fire flat, cover the entire fuel-bed surface with green coal and close the furnace tight. To start the boiler up, open the draft and, after shaking the grates, add more coal. Sometimes fires are banked at the front of the grates, in which case the boiler can be fired up much quicker.

To bank a 150-hp. boiler 24 hours will take about 1,000 lb. of coal when method No. 1 is used. To bank the same boiler 24 hours by method No. 2 will take about 1,400 lb. The second method will keep the boiler furnace heated up more evenly, and flat banking is not satisfactory when volatile coals are used.

Controlling the Steam Pressure

With every given load there should be a given position for the damper. The greater the load the greater will the draft have to be. When there is no load on the boiler, the dampers should be closed tight, and the front of the boiler closed.

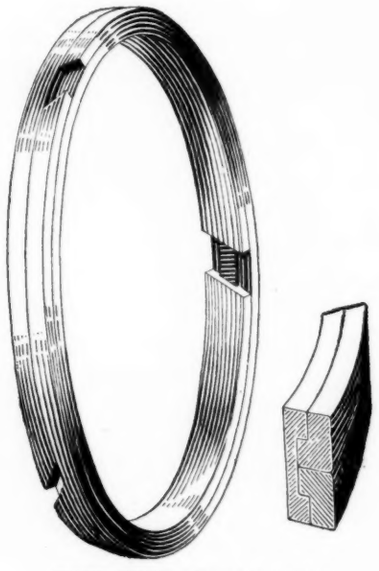
Set the damper at the proper position and fire up the boiler. Keep the furnace doors closed as much as possible, because the cold air cools the furnace gases and heat is lost. When the steam pressure begins to approach the blowoff point, the ashpit door should be closed in order to keep the air from entering the fuel bed and burning the coal when the heat is not needed.

If the steam pressure still rises and the water level of the boiler is below normal, pump feed water a little faster into the boiler in order that it may absorb part of the heat.

When the ashpit doors have to be closed too often, it is a sign that the damper is open too wide.

Zelnicker "Ever-Tyte" Piston Ring

A simple form of multi-piece piston-ring—three rings locked together with a right-angle interlock—known as the "Ever-Tyte," is manufactured by the Ever-Tight Piston Ring Co., 1620 Kingston Ave., St. Louis, Mo. The inner, or keeper, ring is the width of



EVER-TYTE PISTON RING

the groove of the piston and is grooved on the outside surface to take the flanges of the two outside rings, which fill up the groove on the keeper ring. The outside rings are held in place by a dowel pin so that the joints are staggered, thus reducing the amount of gas leakage. The construction of the ring forms a right-angle interlock which closes the points of contact between the members and seals all gaps and compression, thus preventing waste of power. This ring is designed for use in internal-combustion engines, ammonia compressors and in steam engines.

EDITORIALS

Need of an Hydraulic Laboratory

THE American people are apparently to embark upon an extensive campaign of water-power development. The passage by Congress of the water-power bill, the increasing price and precarious supply of coal, the possibilities of electrical transmission, the growing possibility of great interconnected systems to which they may be tributary, the growing demand for power through the electrification of railways to which many as yet undeveloped water powers within reasonable distance of which the roads pass could be contributory, all favor an early and intensive movement in this direction.

The observer who looks back upon the developments of the next thirty years in the light of the knowledge of 1950 will doubtless see many errors and failures; much that could have been better done, much waste and loss that could have been avoided. How many of these mistakes may be shunned, how much more effectively may we spend our money and our effort in developing our water power resources if it is gone about in a systematic and intelligent fashion?

In the past twenty years the attained efficiency of the water turbine has been increased from about eighty to ninety-odd per cent. This leaves little to be accomplished in this direction, but this is only one of the factors. Recent developments have made it possible to operate turbines efficiently at high speeds under low heads. This means the use of lighter and less expensive wheels and generators and a reduction in the installation cost per horsepower or kilowatt. One of the most grievous difficulties about the operation of a waterpower is the loss of head due to back water. At the very time that the greatest amount of energy is coming down the river, in a state of flood, the available fall is so reduced by the backing up of the water below the falls, the incapacity of the channel to carry away the increased flow, that the plant is unable to convert as much of this energy as in times of moderate flow. To install and maintain units enough to meet the maximum demand under the lesser head and to lie idle most of the time is costly. Efforts are being made to provide for utilizing, with the units installed to meet the requirements under ordinary conditions, enough of the energy of the surplus water to make up the deficiency due to the loss of head; to get, by the use of a greater quantity of water under a lesser head, as much power as with the lesser amount under the greater head, for which the turbines were designed, and this with the same machines. A lowering of the efficiency is not material at a time when water is so plenty as to be a nuisance. These and other possible improvements will make profitable the development of powers that might otherwise be unavailable, or the development to better advantage of others more advantageously situated.

Are we going into this development feeling our way with our eyes shut and commit blunders, or are we going to systematically and scientifically study the subject and let our heads save our hands—and money?

What is needed is a national hydraulic laboratory equipped for the scientific study of the flow of water and its conversion into power. Clemens Herschel in a paper presented at the last meeting of the American Society of Mechanical Engineers urges the establishment of such a laboratory and presents a weir the idea of which had lain latent in his brain for twenty years for lack of an opportunity to try it out.

The effective development of its water powers is of moment enough to the nation to warrant the establishment and operation of such a laboratory by the Government. At least it might follow the example of the British Government and contribute toward the establishment and support of such a laboratory a dollar for every dollar furnished by private enterprise. The power companies, the companies interested in the development of hydraulic machinery and those who would profit less directly in the accelerated and perfected development of our water powers could well afford to provide one-half the cost. The Engineering Foundation or the Engineering Committee of the Research Bureau could appropriately serve as the collectors and conservators of the fund. Perhaps it would be a proper activity for the new Federated American Engineering Societies to try its lance upon.

Roof Condensation

MANY power plants in the northern section of this country and in Canada, where temperatures below zero are common in winter, have trouble with so-called "sweating" of the engine room roof. This is particularly troublesome and annoying where there is installed electrical equipment that must be kept dry. In some cases tar-paper covered structures must be erected over motors, generators and switchboards to protect them from these drips.

The cause of this roof condensation is due to variations in the humidity of the air in the engine room. The air around the engines or turbines is heated and its absolute capacity to carry moisture is thereby increased. It tends to saturate itself with any moisture available such as that escaping from steam leaks at valve stems, piston-rod packing, glands or other places. This heated, highly humidified air rises to the roof. In contact with the cold roof it loses much of its heat by conduction and radiation and its temperature drops. The dew point for the amount of moisture present is soon reached and moisture is deposited on all the exposed cold surfaces of the roof, particularly on the metal beams because of their greater heat conductivity. The moisture collects in drops and falls down on machinery and equipment. The air having now become much cooler descends to the floor level, where it is again heated and humidified and the process is repeated.

The trouble can be lessened by making the roof of special heat-insulating construction with dead air spaces, layers of building paper and a wood sheeting. This, however, generally is very expensive. Another method is to build the roof of gypsum blocks, but these are also

expensive. Neither of these methods prevents condensation on the steel roof members. Still another plan is to provide heating coils under the roof. These generally will prevent condensation but are rather extravagant in the use of steam.

A plan developed by one of the large engineering-construction companies bids fair to provide the most satisfactory cure for this trouble. The cooling air from the turbo-generators can be regulated so that the discharge is sufficiently hotter than the room to be used for heating the building. This air is normally carried by a duct to the forced-draft stoker-fan inlet, but may be directed toward the roof of the engine room by a damper in this duct, which opens directly upward in the operating room. The temperature and also the absolute humidity of the air entering the generator are kept low by an air washer which is furnished with cold water from the condenser supply. Hence when this air leaves the turbo-generator it is hot, but with very low relative humidity. It rises directly to the roof absorbing any moisture with which it comes in contact. The turbo-generator draws air through the air-washer from the operating room so that the circulation of air in this room is very rapid. The warm air does not stay long enough in contact with the roof to cool down near its dew point, so that no roof condensation occurs. When the air is cooled during its passage through the cold air-washer sprays, the moisture that has been picked up is effectively removed. This system presents no operating difficulties and appears to be a most satisfactory solution of the problem of roof condensation, as well as providing good ventilation for the operating room. It would be interesting to know how others have attempted to overcome this trouble and with what success they have met.

Ultimately Worth While

THE effect of the railroad rate increases upon coal prices is variously estimated. That an immediate increase in coal prices will result in most districts seems inevitable. The exact magnitude of the increase, however, will depend more upon the temper of the coal man than upon the Interstate Commerce Commission decision itself, it appears. The ultimate effect is, however, less obvious though apparently no less certainly favorable to the coal user.

By limiting coal priorities to New England and the Northwest, with the exception of assigned cars for public utility coal, the Commission in a sense established itself as a fuel administration, fixing the price of coal for utilities and these favored districts. It might as well have said that the buyer will hereafter determine coal prices instead of the seller, for if coal may not move in other directions until given quantities go here, the purchaser in these particular districts can in a large measure determine the maximum price which he is willing to pay and thereby limit the prices charged.

The freight rate order, however, has an entirely different effect. As stated above it means an immediate increase in coal delivery cost and, therefore, probably in coal prices as well. However, it means improved facilities and equipment of the railways, eventually and probably very soon. The ability to move coal should thereby be greatly increased and the benefit of the improved transportation should then eliminate the opportunity for famine prices of fuel, assuming, of course, that the car shortage is, as has been claimed, the greatest factor in the present coal situation. Another season with favorable income and opportunity for accomplishment of deferred maintenance should, it seems, eliminate the extravagant coal prices with which the fuel user has had to contend during the current year.

Why Not Co-operate?

THE country has at last been brought to a stern realization of the necessity for conservation of fuel, both coal and oil. Consequently, engineers are everywhere looking to greater use of water power, and the recently enacted Water-Power Bill is expected to stimulate such development.

There are many sites which can best be developed under private initiative with the safeguards provided in the Water-Power Bill. There are other sites so situated as to make it difficult to attract private capital, and in these cases the Government should take the initiative. Great Falls on the Potomac comes within this latter class. Special provision was made in the Water-Power Bill for its investigation. Yet, at the first hearing on this project a few days ago in Washington, the local electric company interposed strong objections. It appears that the company has acquired certain rights or options, but admits that it has no plans for development and, moreover, no intention of developing the falls. However, it was intimated that the company would be willing to relinquish them to the Government at a substantial profit. Meantime, the company is paying high prices for coal, is doing its share to exhaust the supply, and presumably its customers are helping to pay the interest on these non-productive options.

Such an attitude is economically unsound. Why not encourage the Government to develop the site and through some equitable agreement sell in bulk to the local company, which, in turn, would distribute as at the present time? The existing steam plant of the company would provide the required reserve for periods of low water or peak load. The plan is being worked to advantage on the Pacific coast and would seem just as feasible in the East. It is high time that such problems were viewed broadly and in a spirit of co-operation rather than competition.

May Cut off Natural Gas

FIVE public-service commissions will meet on September tenth to decide important policies with respect to industrial natural-gas supplies. These commissions are considering joint action looking to rules that will cut off natural gas from those who use it for boiler firing, brick making, ceramic manufacture, glass production and similar large-scale industrial uses. The states involved are Pennsylvania, West Virginia, Ohio, Maryland and New York.

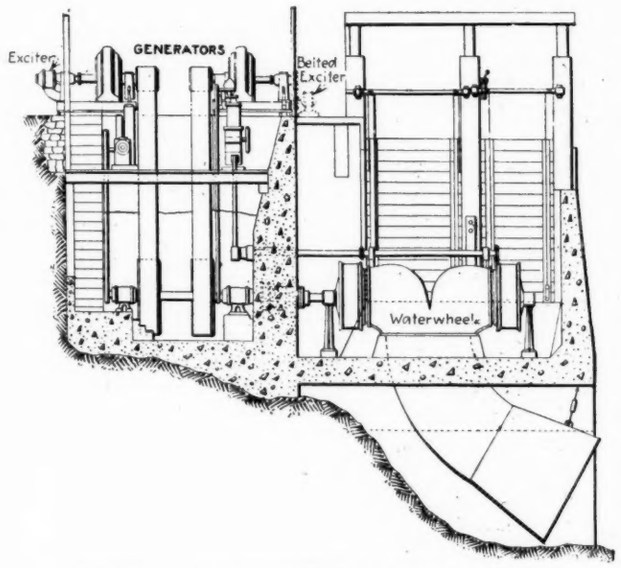
Users of natural gas for boiler firing, unless they have very special demands which can demonstrate the right of priority, will doubtless find it necessary to look to other fuels during the coming winter, and if the program proposed is adopted by these commissions, these users probably will never be supplied with natural gas for boiler firing again, even at low-load seasons. This policy seems to be essential in order that appropriate resting of wells may be accomplished during light-load seasons, thereby increasing the available rate of production for domestic users during peak-load periods.

CORRESPONDENCE

Operating Alternators in Parallel Belted From the Same Shaft

My attention has just been attracted by an article in your July 13 issue of *Power* entitled "Operating Alternators in Parallel Belted from the Same Shaft." In February, 1916, the San Joaquin Light and Power Corporation completed and put into operation a hydro-electric plant on the Merced River at Merced Falls. It was considered a rather unique installation at the time, inasmuch as two separate alternators were to be belted to a single waterwheel and operated in parallel.

The figure shows the general arrangement of the power house with two 225-kw. 600-r.p.m. 3-phase, 2,300-volt generators belted to the one waterwheel. One of



GENERAL ARRANGEMENT OF WATERWHEEL AND GENERATORS

the units has a direct-connected exciter, while the other is belted to its exciter. The exciters are not arranged for parallel operation. Each generator has its main oil switch on the main bus. The total output from the bus feeds through an oil switch to a single bank of transformers, where it is stepped up to distribution voltage.

The operation of the plant is much more simple than might be supposed. If it is desired to shut the plant down the load is reduced to zero and the transformer switch is then opened. The generator switches and field switches are left closed and the excitation gradually dies out as the generators slow down. Getting the units back on the line is quite as simple. None of the switches having been opened, the waterwheel is started and the units are brought up to speed, the excitation building up and holding the generators in step. When the point of synchronism is reached the transformer switch is closed, connecting the plant on the system. While essentially a block-load plant, the waterwheel is connected with a Woodward oil pressure governor which controls the speed should the plant at any time be running separate from the system carrying the local distribution.

There is a slight surging or exchange of current between the generators due to belt slippage, but it is not serious as the voltage is not affected. No trouble has been experienced in the division of load by the generators or their holding in step. In fact the operation has been very satisfactory. As the present belts are badly worn it is proposed in the near future to couple the generators together mechanically and drive them with one new belt, which will result in a trifle better efficiency and eliminate the surging. This was tried out recently and demonstrated to be perfectly feasible.

R. C. DENNY, Operating Engineer.
Fresno, Cal. San Joaquin Light & Power Co.

Back in 1908 I operated a plant where two 2-phase 2,200-volt 60-cycle alternators were connected in parallel from the same driving shaft, and I do not recall any particular operating difficulties. The machines were the same size, 200-kva., with voltage controlled by a Terrill regulator, and each machine had its own exciter.

In 1899 a plant consisting of three 3-phase 440-volt compensated winding alternators was installed to operate from the same driving shaft. A fourth machine was added later. This plant operated without any serious difficulty for twenty years. In this case also the machines were all the same size and make. With two machines of different capacities the story might be different. However, so many queer stunts have been pulled off with alternating-current machinery that I would hesitate to say that it could not be done.

Paterson, N. J. W. H. MOORE.

We have been operating in Derby three belted machines from the same shaft for the last fifteen years and have had no trouble in the operation of them. The installation consists of four waterwheels belted through two belts to a common line shaft, this line shaft operating two 200-kw. 2,300-volt 600-r.p.m. machines; also one 450-kw. 360-r.p.m. machine. All three machines

are placed approximately 25 ft. from the main line shaft. We found some difficulty at first in making the machines take their proper amount of load. All machines are furnished with paper pulleys, consequently by turning down the pulleys to a slight extent we were able to get the machines to operate with a proper division of load. There is absolutely no trouble in bringing the machines in parallel operation. The incoming machine having no load, of course always runs somewhat faster than the machine carrying the load. The usual division of load between these three machines has been about 450 kw. on the larger machine and 150 kw. on one of the smaller machines and 75 to 100 on the second smaller machine. This takes in the full capacity of our waterwheels. We are also able to make a very material change in the amount of load on the smaller machines by a very slight adjustment of the tension of their belts.

M. M. ECKHARDT, Supt. Elec. Dept.,
Derby, Conn. Derby Gas Company.

In the July 13 issue of *Power* I note Mathew King desires to operate a 75-kw. and 120-kw. alternator in synchronism from a common shaft and that the editor states this is highly impractical. I operated a plant for two years which consisted of three 120-amp. monocyclic alternators driven from a common jackshaft by belts.

Two of these machines were synchronized in the usual way and operated on the day load. The third machine was synchronized in with the other two for the evening lighting load. While two of the machines operated together and took their share of the load, yet we were never able to get the third machine to take its share. The belt on the third machine would chirp continually, indicating a continual slip.

All of these machines operated at the same speed, had the same size pulleys and same width of belt. All machines had friction clutches, which also allowed for some slippage. The plant was installed in 1893 and operated night and day until 1907, at which time two 3-phase 200-kw. machines, each driven by its own engine, were installed.

These old monocyclic alternators were installed before the modern oil switches were used. Hence we had only open 3-pole knife switches. One peculiar thing which we did not understand in those days was, No. 1 or No. 2 alternator could be disconnected from No. 3, but No. 3 could never be taken away from Nos. 1 or 2, because it could not be made to drop its load, but the load could be reduced on the other two by cutting down the exciter voltage. When the load was heavy the only way we could separate the alternators was by slowing down until it was safe to open the switch. We were always troubled with cross currents. This was apparent from a continual swinging or darting of the ammeter needle.

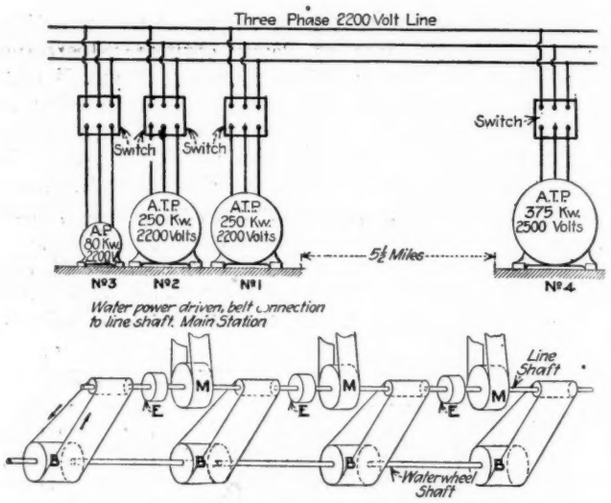
These alternators had a great many peculiar characteristics which I will not attempt to narrate here, but I would advise Mr. King to get one alternator large enough to carry the load or else divide the load between the two machines and not attempt to operate them in synchronism.

WALDO WEAVER.
Canton, Ohio.

In answer to Mather King's letter in the July 13 issue, would say that we have two 100-kva. 2,300-volt 900-r.p.m. alternators belted from the same shaft and have never been able to run them in parallel satisfactorily. We changed the pulleys and turned them down several times but the only way the machines would operate together was by slackening the belt on the high unit and letting it slip. It was impossible to get them the same speed. We finally divided the load and ran the machines separately.

BERNARD G. BROWN.
Attawaugan, Conn.

In the figure is shown the general arrangement of shafting in a water-power plant in New Hampshire where three alternators driven from the same shaft are operated in parallel. The belts marked *B* run from the waterwheel shaft to the main line shaft. Those marked *M* are belts to the three generators, and *E*, *E*, *E* are driving pulleys to three 15-kw. exciters. Nos. 1, 2 and 3 represent the electrical end of the station driven by water power and No. 4 is an engine-driven unit, located 5½ miles away, for auxiliary service. These machines



BELT, SHAFTING AND ELECTRICAL LAYOUT

may be connected in parallel or operated independently. The two 250-kw. machines were installed when the station was first built in 1894.

When the water power and steam stations are used at the same time we always let the waterwheels take all the load they can and allow the engine to govern and take care of the peaks, since this gives us the best economy in operation.

R. A. CULTRA.
Cambridge, Mass.

We have had considerable experience in days gone by in operating alternators in parallel off the same jack shaft. There has been quite a number of plants operated in this way for years without any serious difficulty. In putting these generators into service it is, of course, necessary to get pulleys of exactly the same size. In a number of cases this has been done by using wooden pulleys or by lagging iron pulleys and making final adjustment to size by sandpapering the pulleys with sandpaper fastened on a block.

In measuring the diameter of the pulleys a steel tape should be used and the circumferences made as nearly the same as is possible before starting to synchronize. It may take two or three trials, under operating conditions, to get the pulleys to the proper diameter so the machines will run without cross currents. The machines may have to be thrown in a little out of step in synchro-

izing unless one wants to go to the trouble of slacking off the belt on the incoming machine. Machines once in parallel will stay together and the load can be adjusted by belt tension.

N. L. REA, Const. Eng.,
Schenectady, N. Y. General Electric Co.

The power equipment in our plant consists of one 150- and one 175-hp. Corliss engine—connected to a lineshaft by means of belts running on clutch pulleys. To this lineshaft are belted two 120-kw. 440-volt 3-phase 60-cycle generators which were installed over 20 years ago. These machines, while they are identically the same, were never operated in parallel until about a year ago, after some of the armature coils burned out on one of the units. After replacing the coils it was decided to parallel the machines. As soon as this was done I noted the load shift to the repaired generator. A rumbling noise started and a moment later one of the coils burned out. Since then the machines have been run separately. Of late the load has been too heavy for one generator and we divided it into two separate systems.

JOSEPH VILLIGER.
Dixon, Ill.

In taking charge of a plant that had two alternators operating in parallel from the same lineshaft, I was told that when I got around to it I might investigate why one machine took more load than the other. Thinking that one machine had a tendency to run faster than the other, I sprinkled a little water on the belt of the machine taking the heaviest load, the temporary slipping of the belt caused the load to be shifted to the other machine. After this I turned the pulleys down several times in an endeavor to obtain the proper speeds to divide the load properly, but found it impossible except for short periods. Finally we belted each machine to its own prime mover and had no further trouble.

I am of the opinion that it is not practical to run two machines from the same lineshaft if you want each generator to carry its share of the load. I might add that although it was almost impossible to tell which machine was running the faster, using a stop watch and counter, the slight difference in speeds gave a load of 220 kw. on one machine against 90 kw. on the other.

Pawtucket, R. I. RICHARD DILWORTH.

Referring to the article in *Power* for July 13, 1920, in regard to "Operating Alternators in Parallel Belted from the Same Shaft," in one of the hydro-electric plants of this company we operated for five years two 200-kw. 600-r.p.m. 60-cycle alternators belted to pulleys on the same waterwheel shaft. Only one alternator was used during the day, but both were run in parallel every night. The armature windings of the two generators are quite different, one having form-wound coils in open slots, the other having semi-closed slots.

The same alternators are still in use, but owing to changes and reconstruction in the plant, they are now driven from separate waterwheels. As a matter of fact we found it much easier to synchronize the generators when belted to the same shaft than when driven from different waterwheels as at present.

The point is that all belts slip more or less, making it easy by a slight adjustment of belt tension on one or the other of the alternators to bring the two into synchronism. After throwing the generators in parallel, in order to divide the load properly it is only necessary to loosen the belt slightly on the alternator tending to take more than its share of the load or to tighten the belt on the other machine.

At the start it is evidently necessary to see that the pulley diameters are correct; that is, such that the two alternators tend to run at almost exactly the same speed.

Aspen, Col. C. E. DOOLITTLE, MGR.
Roaring Fork Electric Light & Power Co.

[Other discussion letters have been submitted to date on Mr. King's problem. G. E. Lyons, Woodhaven, N. Y., expressed the opinion that it is impracticable to operate the two alternators in parallel when belted to the same lineshaft. A. C. Barker, Oxford Electric Co., Mechanic Falls, Me., states that his company has, in one of their plants, been successfully operating two alternators in parallel belted to the same shaft. T. H. Dion, Draper Corp., Hopedale, Mass., reports operating two alternators in parallel for 20 years which are belted to the same lineshaft. J. H. Bender, superintendent Municipal Light & Water Department, Clayton, N. M., says he has for 2½ years operated fairly successfully two alternators in parallel arranged according to Mr. King's proposed scheme. These machines are now driven by separate engines; however, this is not on account of any difficulty encountered in the operation of the machines, but to additions being made to the plant. L. S. Henley, National Park, N. J., reports installing two 80-kw. 2-phase alternators which were made to operate successfully in parallel when driven from the same lineshaft. Mr. Henley also tells of another installation where successful operation of two alternators in parallel, of different makes, was obtained with the lineshaft driven by a waterwheel and steam engine jointly. G. E. Shaw, Central Falls Mazda Lamp Division, General Electric Co., Central Falls, R. I., explains how he has made two 150-kw. alternators operate in parallel when driven from the same lineshaft, and these machines operate in parallel with a 460-kw. waterwheel-driven alternator. Division of load between the machines is taken care of by changing the tension of the belts. It is regretted that space limitation will not allow publishing in full all the discussion letters submitted.—EDITOR.]

Cement-Lined Stoker Coal Chutes

About a year ago Joseph Davis, superintendent of construction for the Illuminating Company of Cleveland, Ohio, installed some automatic stokers. From previous experience he had found that the taper chutes connecting the storage hopper and the stoker hoppers had a tendency to wear in a short time, and as an experiment he lined them with mortar made of one part cement and two parts sand. The mortar was 1¼ in. thick and reinforced with common poultry wire. The chutes being on a steep angle, it was necessary to place the material rather dry in order to hold.

Recently, one of these chutes was removed and an examination showed that the mortar had not cracked, nor did it show any signs of wear, although it had been in use for at least a year.

The company is planning to adopt this method on all of its automatic stokers, using a cement gun for placing the mortar on future work.

J. H. WILLIAMS.
Cleveland, Ohio.

Determining Weight of Ammonia in Circulation

Mr. Gavett's methods of calculating the weight of ammonia in circulation in a refrigerating plant, as described in *Power* for June 29 are interesting.

In the first method (pressure-volume), it seems that the whole calculation hinges on the reading of the temperature of the ammonia gas at the end of compression

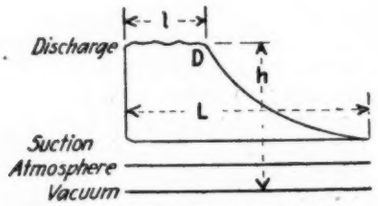


FIG. 1. MR. GAVETT'S DIAGRAM

(point *D*, Fig. 1; Fig. 3 in Mr. Gavett's article). So far as I know, no method has yet been commercially developed that will give one a reading of this vital temperature. Without it, the whole of Mr. Gavett's analysis falls down. Fig. 3 shows an approximate pressure-volume diagram.

The ordinary mercury test thermometer in an oil well will not give accurate readings of temperature of

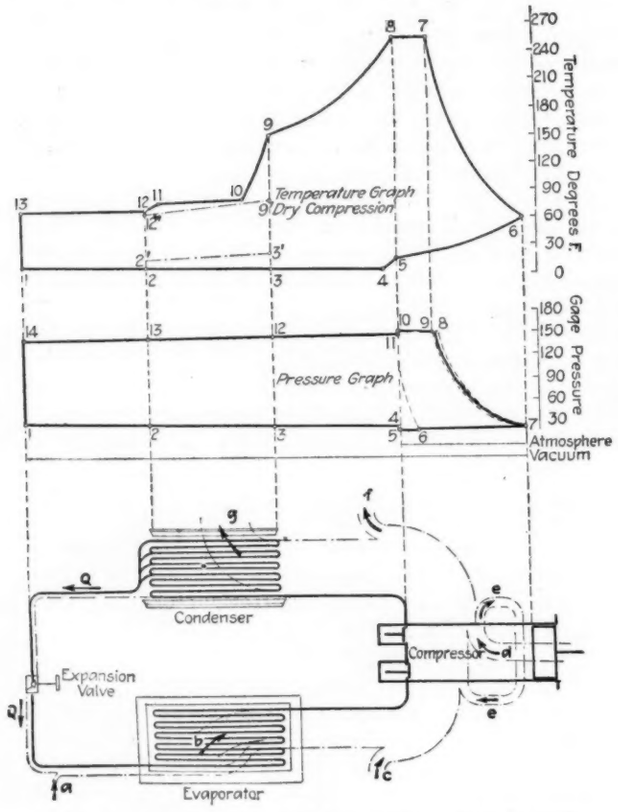


FIG. 2. TEMPERATURES AND PRESSURES IN THE AMMONIA REFRIGERATING CYCLE

a superheated gas, according to the Belgian authority. M. Armand Duchesne (in *Revue de Mecanique*, March 31, 1912). He found that in measuring the temperature of superheated steam the mercury oil-bath thermometer is unreliable. He found that there was a difference between the temperature as indicated by the hyper-thermometer and that indicated by the mercury thermometer in an oil bath as high as 85 deg. C. (153 deg. F.) at low pressure (17,084 kg. per sq.m., or 24.2 lb. per sq.in.) falling to 43 deg. C. (78 deg. F.) at the pressure of 66,930 kg. per sq.m., or 95 lb. per sq.in. In general he believes that in many cases where the temperature has been measured by the mercury thermometer in an oil bath, the temperature of superheat is much

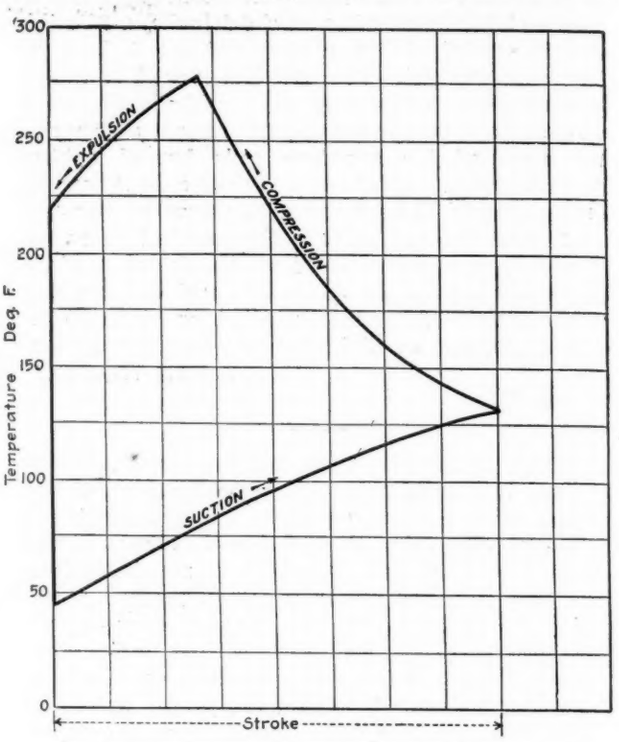


FIG. 3. APPROXIMATE TEMPERATURE-VOLUME DIAGRAM

higher than the measurement would indicate. Where a hyperthermometer cannot be used, an ordinary mercury thermometer placed direct in the steam will show the temperature sufficiently correct for most practical purposes.

TEMPERATURE OF SATURATED AMMONIA

(For use with accompanying Mollier Diagram.)

Pressure, Lb. per Sq.In.	Temperature, Deg. F.	Pressure, Lb. per Sq.In.	Temperature, Deg. F.
5	—62	50	22
6	—57	60	30
7	—52	70	38
8	—48	80	45
9	—44	90	51
10	—40	100	56
11	—37	120	66
12	—34	140	74
13	—31	160	82
15	—26	180	89
17	—22	200	96
19	—18	240	107
21	—14	280	118
23	—10	320	127
25	— 7	360	135
30	— 0	400	143
35	6	450	152
40	12	500	160
45	17	550	168
50	22	600	175
60	30	...	..
70	38	...	..
80	45	...	..

Not only will the discharged temperature as read by an ordinary test thermometer in an oil well in the discharge pipe be incorrect as indicated above, but also the temperature of the discharge if correctly known is *not* the temperature at the end of compression, namely at point *D* of Mr. Gavett's diagram. The following quo-

ation is from a paper by J. H. H. Voss, read at the December meeting of the American Society of Refrigerating Engineers entitled "Heat Balance of the Ammonia Compression System." Referring to his Fig. 7 (here Fig. 2), Mr. Voss says:

"From point 6 to point 7 the temperature rises rapidly during the compression of gas. During the expulsion period there is a drop in temperature, which is noteworthy because the compressor is cooled by it. Unfortunately, no observations as to the extent of this drop are available, and it seems difficult to calculate it accurately. Investigation of this point seems desirable."

in 1910 or 1911 by Charles Jonnson of New York. He claimed that this rise in temperature was in inverse proportion to the cylinder diameter, or

$$\text{Inside superheat} = \frac{669 \text{ deg } F}{D} \text{ (inches)}$$

irrespective of speed, type, etc. Whether or not we agree with Mr. Jonnson in detail, his formula gives a first approximation. A Mollier diagram (Fig. 4) is here shown to assist the reader.

For the case in point, namely, an 8-in. diameter cylinder, the inside superheat by the above formula would

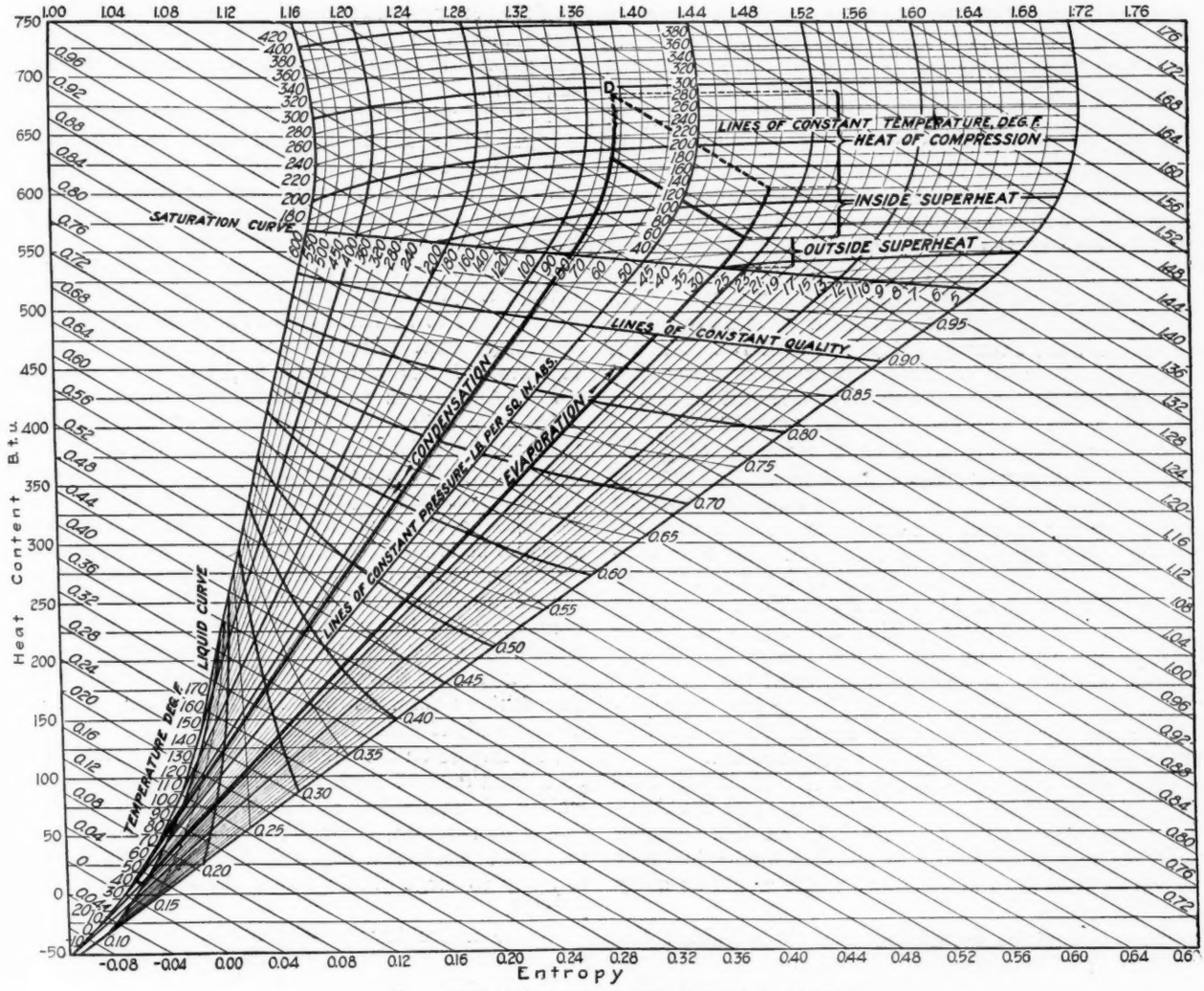


FIG. 4. THE MOLLIER DIAGRAM FOR AMMONIA
(By the Late W. E. Mosher, University of Illinois Bulletin.)

A further examination of Mr. Gavett's data indicates the danger of calculating refrigeration by this method.

The suction gas pressure was 29.2 lb. abs. with a temperature entering compressor of 46.5 deg. F. Assuming that there was no further heating of the gas during the suction stroke, then during adiabatic compression (to point *D*) to discharge pressure of 82.7 lb. abs., the gas temperature would be increased to about 180 deg. F. Mr. Gavett's reading was only 138.5 deg. F.

As a matter of fact, there is heating of the gas during suction stroke. An empirical formula for the amount of the "inside superheat," i.e., temperature rise within the cylinder during the suction stroke, was advanced be 83.5 deg. F. Adding 83.5 deg. F. to the suction gas temperature of 46.5, gives a temperature at end of suction stroke of 130 deg. F. With adiabatic compression from 29.2 lb. abs. to 82.7 lb. abs., the temperature at the end of compression (point *D*, Fig. 1) would rise to about 280 deg. F. I do not put forward 280 deg. F. as the accurate temperature, for it is based on an assumption (Jonnson's); but it is much nearer correct than 138.5 deg. F.

In conclusion, I would make the suggestion that those with the scientific equipment available, solve this problem once for all by use of hyperthermometers.

New York City. G. H. CRAWFORD.

Should These Conditions Continue?

During the last few months I have visited twenty-one power plants, to ascertain for my own information the existing conditions. These plants range from one hundred to six hundred boiler horsepower. Out of the twenty-one plants four had furnaces equipped with draft gages, which were the only instruments provided for the economical use of fuel. A few of those plants were modern in every respect as to the building and the power equipment, but in the majority there is a waste of 20 to 30 per cent of the fuel. The engineers or firemen did not take the interest they should in the economical use of the fuel, and the management was too busy with production to look into the matter

In one plant in particular there are two hand-fired horizontal return-tubular boilers that are used for heating and drying purposes. I visited this plant on the first of June and the two boilers were in use. In passing through the plant, I noticed that the radiators were warm, while the windows were open. The manager told me that they intended to put in another boiler to take care of the heating of a new addition to the plant. The two boilers that they have at present will take care of all the heating and process work they require. The fireman does not know what a draft gage is or what the chimney damper is used for. He was firing the furnaces with the ashpit doors closed and the chimney damper wide open. Who should be blamed for this waste of fuel and poor management?

On presenting my card to a manager of a six hundred horsepower plant, he looked me over as though I were a bandit, and before I could say anything regarding my errand, informed me that he had had all the expert advice that he cared for. After explaining to him that I was not trying to impose upon him to take any advice or to retain my services, he told me of a man that had come to him, claiming to be a combustion engineer, and that he could save him 25 per cent of his fuel. After hanging around the plant for seven days and charging a fee of $10 per day, the conditions were the same as before he started to save the 25 per cent, besides the loss of a good fireman.

In another case the management of a plant was complained of because of the smoke issuing from the chimney. The expert that was called in on this occasion gave the intelligent advice to install a mechanical soot blower to keep the tubes cleaned, which would do away with the smoke.

There should be something done to enlighten the operators and management of the small plants to reduce this waste of fuel to a minimum. The small plant has to pay the same high price for fuel as the larger ones, and as long as this waste goes on the mines must produce an extra amount to supply the demand, which has a tendency to keep the prices up.

There should be some means whereby men that follow the business of expert adviser for power plants should be compelled to undergo examination to prove their ability to give such advise. These examinations should be held by a board of experts of long standing in this business. If the board finds the applicant capable, he should be awarded a certificate of merit, which should be registered with some responsible official in the vicinity where he is to ply his business, thereby assuring the management of power plants against incompetent persons.

C. J. MILLER.

North Tonawanda, N. Y.

Day Versus Night Repair Work

In every power plant there is a certain amount o small repair work that is usually left for the operatin crews to clean up; that is, the routine repair work tha is not large enough to take up the regular repair crew' time. This condition has created an intense argumer between the day and the night crews in a large plan where it is customary to leave a goodly portion c routine repairs for the night crew. About three-fourth of the night crew work a steady night turn, not change turn. The man in charge at night works wee about. The men working a regular night shift come o at 5:30 p.m. and are relieved at 7 a.m. For these extr one hundred hours per month they get an average o $10 per month more than their respective reliefs on th day turn.

The man who has charge of this station never worked a night trick. He doesn't understand the various conditions that rob a night man of his valid share of rest. He doesn't know anything about the long, hard hours on a night watch, after midnight, for a man who has to keep awake to watch monotonous operation.

Therefore this superintendent thinks nothing of leaving a cylinder head to be slugged up or a set of piston-rings to be fitted to a new piston, by the night operating crew. Another one of his pet hobbies is to leave a lot of pipe work to be done on the night turn. Another is to complete the cleaning and repairs on a boiler that has been down for probably a week and have the night crew cut it in during the night, and cooling off some other boiler for repairs. Regarding the last-named practice, there should be a law against the criminal practice of manipulating high-pressure boilers on the night turns in any power plant.

The recent explosion at East Chicago is ample reason for calling it criminal practice. There is no possible excuse for the insane contention harbored by far too many bosses, that the night crew in their plants must be kept busy. And there is still less excuse for any superintendent or foreman who has boilers cut in or out during a night watch.

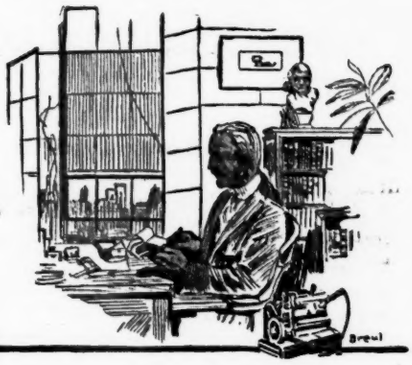
Why impose on the night men around a plant? They do a good deal of work that the day crew takes as a matter of course, but at the same time, if the crew should be reversed, it would, in nine cases out of ten, turn the organization almost inside out. This is meant to apply to large plants where the operation is complicated.

We are not looking for a feather-bed because we work nights; we do not expect something for nothing. We fellows merely want fair play. We feel that we have done our bit when we have operated our equipment to the best of our ability and are making station records consistent with good operation in our respective plant. And on account of the long hard hours it is not just to expect us to do a lot of extra repair work as well as take care of our operation. While we believe in consistent effort (hard work never hurt anyone), we also believe that there is a limit to a night man's endurance; we believe there is a limit to his physical worth, who puts in thirteen hours on a night watch.

Operating engineers do not want to be misconstrued in this matter; they are not looking for a well-oiled volume of sympathy, but they feel that they have just grounds for an earnest appeal for more considerate treatment of the fellows who have to work nights.

Chicago, Ill. J. J. JAHOBART

INQUIRIES OF GENERAL INTEREST



Beading Tube Ends of Fire Tube Boilers—How is the holding power of tubes of fire tube boilers affected by beading-over the ends? R. A.

The operation of beading over the tube ends has a tendency to drive the expanded tube from the hole in the tube sheet and thus impair the tightness of the joint and excessive beading produces granulation and reduction of strength of the material. But when the operation of beading is carefully performed on good tube material, the holding powers of beaded and flared tubes are about the same, with the advantage of greater durability of beaded tube ends over those that are simply flared in resisting the burning action of the fire.

Condenser Pressure Not Ascertainable from Temperature—Why cannot condenser pressure be known by simply obtaining the temperature and ascertaining the corresponding pressure from tables of the properties of steam? W. A.

The absolute pressure within a condenser is made up of the pressure due to the steam or water vapor present and the pressure due to the gases present, generally called air as the greater part of such gases usually consists of air. The total condenser pressure cannot be obtained from steam tables because the temperature is that corresponding to the pressure of only the saturated steam that is present, which would be something less than the total pressure, depending on the amount of "air" contained in the mixture.

Specific Gravity Corresponding to Baumé Degrees—What are the specific gravity values corresponding to gravities of petroleum oils quoted in Baumé degrees? L. P.

The corresponding values of the Baumé scale and specific gravity within limits most used in connection with petroleum are as follows:

Baumé Deg.	Spec. Grav.	Baumé Deg.	Spec. Grav.
20	0.9333	34	0.8536
22	0.9210	36	0.8433
24	0 9090	38	0.8333
26	0.8974	40	0.8235
28	0.8860	42	0.8139
30	0.8750	44	0.8045
32	0.8641	46	0.7954

Heat Energy Realized per Pound of Coal—What per cent of the heat energy in the fuel is realized by an engine in a plant where the coal used contains 12,000 B.t.u. per pound, the evaporative economy of the boilers is 7 lb. of water per pound of dry coal, the economy of the engine is 32 lb. of water per i.hp., and the mechanical efficiency of the engine 88 per cent? R. H. D.

With evaporation of 7 lb. of water per pound of coal, the fuel consumption would be $32 \div 7 = 4.57$ lb. of coal per i.hp.-hr. and for 88 per cent mechanical efficiency, the energy realized would be $\frac{33{,}000 \times 60}{4.57} \times 0.80 = 346{,}608$ ft. lb. or $346{,}608 \div 778 = 445.5$ B.t.u. per pound of the coal; and for coal containing 12,000 B.t.u. per pound, the per cent of heat energy realized would be $445.5 \times 100 \div 12{,}000 = 3.7$ per cent.

Permissible Back Pressure for Heating Feed Water—To what extent is it economical to increase the back pressure of a non-condensing engine for raising the temperature of boiler-feed water delivered by an exhaust-steam feed-water heater? A. R. D.

Within moderate limits, the total steam consumption of an engine increases substantially in direct proportion to the increase of the load, or increase of mean effective pressure, and each additional pound of average back pressure increases the total steam required for a given load the same as though the load had been increased to require as much additional mean effective pressure as the added back pressure. Under average conditions, where an exhaust-steam feed-water heater is employed only for heating water for generation of steam supplied to a non-condensing engine, for one pound of additional back pressure on the engine there will be obtained an increase of about 3 degrees additional temperature of feed water, depending on the efficiency of the exhaust-steam feed-water heater, and for each degree of feed water there will be a saving of about $\frac{1}{10}$ of one per cent of heat required for generation of the steam used by the engine. Under these conditions, the limit of advantage is reached when the cost per degree increase of the feed water is $\frac{3}{4}$ lb. per sq.in. of additional back pressure, and when for each degree rise of feed-water temperature the increase of back pressure amounts to $\frac{1}{30}$ of one per cent of the mean effective pressure.

Connecting Water Column of R. T. Boiler—How should a water column be connected to a return-tubular boiler? R. M. P.

The pipes connecting the water column to the boiler should be not less than 1 in., with the steam connection taken from the top of the shell, or the upper part of the head, and the water connection should be of brass pipe taken from a point not less than 6 in. below the center of the shell and provided with plugged cross fittings at angles to facilitate cleaning. The water column, or water connection, should be provided with a drain cock or drain valve with suitable connection not less than $\frac{3}{4}$ in. to the ash pit or other safe point of waste. Both the water and steam connections should be provided with a shutoff consisting of either outside screw and yoke type gate valve or stop cock with permanent lever and such valves or cocks should be locked or sealed open and located as close as practicable to the boiler. The water column should be provided with water glass stop and drainage fittings set at such height that the lowest visible part of the glass gage will be not less than 4 in. above the upper row of tubes, and unless there are two water columns located on the same horizontal line and not less than 2 ft. apart, the water column should be provided with at least three gage cocks located within the range of the visible length of the water glass, unless the boiler is otherwise provided with the same number of gage cocks located at similar levels.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Some Features of Modern Hydro-Electric Practice*

By H. M. TURNER

THE modern water-power station was not developed until after the middle of the last century, and in the last twenty years it has reached its present state of, one might almost say, perfection.

The modern turbine is distinct from other types of wheels—the old waterwheels and the modern impulse wheel, which operates in the same manner as the paddle wheel on a steamer, a jet of water at high velocity turning the veins on a wheel with which it comes in contact—in that the turbine wheel is always full of water, the buckets of the wheel are completely filled, and the passage from the headrace above to the tail water below is practically completely a solid column of water, the power being obtained from the reaction of the water against the bucket of the waterwheel. In the modern waterwheel the water enters all the way around the wheel and discharges inward and downward. In the impulse wheel, which is used only for very high heads, it is a jet which impinges on veins on the edge of a wheel and then falls dead into the pool below, in the air. The head over which the water falls is usually divided into two portions—the head acting on the wheel direct in the form of pressure, and a head acting in the form of the suction of a column of water after it leaves the wheel in the draft tubes.

The early types of wheels had small, short draft tubes, but the modern wheel is set well above the tail water and has a column of water, perhaps 18 or 20 ft., pulling down on the wheel. This long draft tube has a distinct advantage. The head or power in water can exist as pressure head or as what is called velocity head; that is, water moving at high speed has a power in it due to its velocity corresponding to a certain definite height or pressure of still water. The water in the turbine leaves the runner at high speed. It may be 15 or 20 ft. per sec. or higher. This represents considerable energy in the water which, if it were allowed to discharge at that rate, would be wasted. The draft tube provides a means of gaining back that velocity head, that power in the speed of the water. By gradually enlarging the draft tube so that the water is "stilled down" we can bring the velocity at the outlet of the draft tube to perhaps four or five feet per second and discharging at that low speed little head is lost. That is one of the improvements of the modern waterwheel.

To those "Power" readers who are not familiar with water-power plant practice, this hydro-electric abstract will be of interest.

The other improvements in recent years have given high speeds and greater efficiency. The development of electrical generators direct-connected to waterwheels has required the waterwheel designer to get the speed up as high as he can to reduce the generator cost of the unit Waterwheels have now reached a stage where an efficiency above 90 per cent can be reached, sometimes as high as 91 or 92 per cent at the point of speed and gate opening which is most efficient. That is usually something less than full gate, that is, something less than the widest opening of the wheel gates. The efficiency then usually drops off as the gates are opened wider, until the usual waterwheel will have an efficiency of somewhere above 80 per cent at its point of greatest power, or full gate. On the other side—that is, on the part load side—going down from the highest point of efficiency, the efficiency is maintained pretty well up to half-load or half-power; it may be above 75 per cent, and from that point on it rapidly declines. That gives us a curve that at the best point of efficiency reaches 90 per cent, and at any point between three-quarters and full load it will be above 80 per cent. Formerly, with small units, the open flume was frequently used. That was suitable for small units. In that form of setting, which was a good one, the velocity of the water has to be kept low to get the best efficiency and to eliminate eddies. The next step was the closed flume, where the water is introduced to the wheel in a closed, usually a metal, casing.

To be efficiently used, the course of the water must be free from abrupt turns. Abrupt enlargements or contractions are not permitted as they cause eddies.

The modern low-head unit uses a large vertical runner with a so-called scroll case, or spiral case, where the water is brought down to the wheel and then carried in a spiral passage of gradually decreasing section around the rim of the wheel, so that the velocity change is kept at a nearly constant rate. That installation has another advantage, in that the gate rigging, the arms that operate the gates around the waterwheel, can be taken out into the open, where it can be inspected, whereas with the older form of horizontal waterwheel units in a case, if they were a pair of wheels particularly, the gate rigging on one wheel would have to be submerged. The higher-head units are often made horizontal. Developments in the gates and gate mechanism have helped produce the high efficiency obtained today.

The other chief development in recent years has been in the size of units as well as in their efficiency. The Keokuk development was one of the early installations of large single units set in concrete cases, which practice is now being followed. This type gives the efficiency of the vertical setting, with good water passages, and the spiral case gets rid of any bearing under water, the bearing being carried either on top of or immediately below the generator, between the waterwheel and the generator itself.

Drainage area is as essential a part as is head itself. The character of the drainage area is important, too. The amount of natural storage and its elevation count materially in the yield had from the drainage area. The dry periods of summer and the flow conditions of spring represent a tremendous contrast. The water-power plant has seasonable variations in flow and yearly variations in flow, good years and bad years, dry years and wet years. The average water-power plant does not use more than one-third to one-half of the water that flows down the river, so irregular are the streams in their discharges. On the Connecticut, for instance, the greatest flood amounts to 20 cu.ft. per second, while the minimum in the dry period will not be more than 0.3 cu.ft. per sec.

Both those conditions of river flow, both the low-water period in summer and the very high flood conditions in the spring, limit the output of the water-power plant. The waterwheel will not take more than so much water. In the flood season the river rises below the wheel, and the head is cut down because of the rise of water in the river. At the time we have the greatest amount of raw material (water), the amount of power available is cut down. This is something that should be corrected and storage seems the only practicable way to do it.

Pondage near the power plant to provide for the daily fluctuation in load is important. In modern water-power development great attention is paid to the pond and its regulation. In the older plants the dams were built solid across the stream without provisions for waste or sluice gates for maintaining flash boards on the dam. To prevent these flash boards being washed out by every rise of water, sluice gates or waste gates are provided to take the water under or around the dam, so that the boards may be maintained in place.

*From a paper by the author before the New England Load Dispatchers' Club.

Elaborate provisions have been made in some cases for handling the flash boards. There is a plant out in Spokane, Washington, which has a flash board consisting of three rolling lift dams. The flash board is 19 ft. high and operates with large rollers which roll up on a geared track, so that they can be handled as a large movable dam. During flood seasons they are elevated and the flood passes under them. During the seasons of dry water they are lowered, thus the plant gains the benefit of that 19 ft.

We are very much more bothered with questions of ice, which are likely to interfere with any structure of that sort across the top of the dam itself. Heavy ice pretty nearly requires an even, clean spillway during high water in order to get rid of it, and any obstructions in the shape of piers are usually unwise; but we get around it by means of putting on temporary flash boards and providing these gates, and perhaps methods of handling the flash boards when there is water flowing over them so as to keep them on as long as possible and as much of the year as possible.

Another factor of importance is that of relief, or you might call it the safety valve, necessary in case of a sudden shutdown. The long or short column of water in the penstock has a large amount of energy. In case of a short-circuit the wicker gates are closed by the turbine governor. The energy in the moving column of water must be dissipated in some way. Some relief must be provided, and is usually had by means of a tank which takes the surges of the water. At Turners Falls, at the Cabot station, there is a large forebay pond immediately at the head of the power station which serves the same purpose. Not only in case of a sudden shutdown, but also in case of a sudden load coming on the wheel, relief of that sort is necessary. A sudden load coming on tends to draw down the canal. In cases of a long pipe line it has been known to draw the water out of the pipe line. High-head plants usually have elaborate surge tanks provided to take care of the fluctuations in head due to sudden changes in the velocity of the water leading to the wheel.

There is a limit to the overload capacity on the water-power plant which is not true to the same extent of the steam turbine. Once the waterwheel gates are open wide, no more power can be had from the wheel—no momentary overload is permissible as it will slow down the wheel. It is advisable to run the waterwheel with its gates only part way open. With such opening not only is best efficiency had but it also gives reserve capacity in the case of a sudden draft.

Hearing on Great Falls Power Project

Advantages to be obtained from the development of power at Great Falls, on the Potomac, were painted in roseate colors at a hearing before the Federal Power Commission Aug. 24. Representatives of the civic bodies in the District of Columbia and witnesses from nearby points in Maryland and Virginia urged the development of the project. Representatives of the Potomac Electric Power Co. appeared in opposition to the project.

S. R. Bowen, vice-president of the Potomac Electric Power Co., explained that his company had secured the power rights at Great Falls, with the expectation of developing it, but examinations by its engineers led to the conclusion that the project could not be developed as a commercial proposition under existing conditions. He admitted that the company at this time has no plans for utilizing this water power. Any hydro-electric plant that might be established would have to be duplicated by a steam plant to take care of needs during periods of low water. When Secretary Payne asked if the company would be willing to dispose of its rights at the Falls Mr. Bowen replied that it would do so for adequate compensation. This led Judge Payne to ask if it would become suddenly very valuable if the Government should think of taking over the rights. Mr. Bowen replied frankly in the affirmative.

R. Walton Moore, the representative in Congress of the Virginia district which adjoins the District of Columbia, pointed out how manufacturing could be stimulated within a radius of 200 miles around the Falls if the maximum amount of power were developed.

The Engineer Commissioner of the District of Columbia, Col. Charles W. Kutz, urged the development of the power project, even if no reduction in the existing rates results. Such a development would carry with it a reduction of the smoke evil in the capital and would permit a diversion of considerable quantities of coal for other purposes. He suggested that the large steam plant of the Potomac Electric Power Co. should be utilized in connection with the development and could either be purchased by the Government or operated under an agreement with the company.

W. B. McCaleb, representing the Pennsylvania Railroad Co., stated that his company is not interested in electrification at this time because of financial considerations. While he admitted that his company is interested in cheap power at any point on its lines, his position is that the transition from steam to electricity requires a greater capital outlay than would be justified in Washington and its vicinity. The representative of the Washington Terminal Co., which is owned jointly by the Pennsylvania and the Baltimore & Ohio Railroads, testified that no serious thought has been given to the electrification of the terminal.

Col. Lafe Pence protested against the construction of any dam which would prevent the use of the right-of-way of the Chesapeake & Ohio Canal for a railway outlet. By filling in this canal, a right-of-way for the Western Maryland, Norfolk & Western and the Cumberland Valley Railroads would be provided, forming the best grade from the coal fields to tidewater.

The matter of securing an additional water supply for the District of Columbia also was considered at the hearing. All witnesses favored the development of the water supply for the District as a separate project from the power development.

The hearing was presided over by the Secretary of War, who is chairman of the Federal Power Commission. Secretaries Payne and Meredith and Executive Secretary O. C. Merrill were in attendance.

Agreement Between Bureau of Mines and Coal Exchange

Much importance is attached to the co-operative agreement which has been entered into by the Bureau of Mines and the Sewalls Point Coal Exchange. The agreement provides for an analysis of the coal shipped to tidewater pools with the idea of improving the grading and classification. The negotiations for the Bureau of Mines were conducted by O. P. Hood. The agreement is signed by the Secretary of the Interior; F. G. Cottrell, Director of the Bureau of Mines; G. H. Caperton, president and S. T. Snead, secretary of the Sewalls Point Coal Exchange, Inc. The text of the agreement in part is as follows:

The United States Bureau of Mines and the Sewalls Point Coal Exchange, Inc., Norfolk, Va., desiring to conduct investigations concerning preparation of coal with a view to increasing efficiency agree that all works shall be directed by the Bureau of Mines according to a program as mutually agreed upon between the Bureau and the Exchange.

In the district to be investigated, the Bureau agrees to complete a list of mine samples and analyses and to obtain at the mine tipple, point of delivery or other place as agreed upon, representative samples of the commercial coal as shipped by the several mines.

The Bureau agrees to make, at its Pittsburgh laboratory, proximate analyses and B.t.u. determinations of all samples which are acceptable to the Bureau, and ultimate analyses and fusing temperature of ash determinations of such samples as may be mutually agreed upon.

The report of the Department of Commerce, Bureau of Foreign and Domestic Commerce, Washington, on domestic exports from the United States of refrigerating machinery during June shows that machinery valued at $245,045 was exported. Japan leads in imports valued at $130,252; Cuba is second with imports valued at $38,571, and Brazil is third with imports valued at 28,222.

To Prosecute Coal Profiteers

In a letter to all district attorneys, the Attorney-General again has called attention to the necessity for taking rigorous action against those who unduly enhance the price of coal. The letter reads:

In connection with previous instructions to investigate and institute prosecutions in cases where unreasonably high prices have been exacted in the sale of bituminous coal, you are instructed to investigate cases where the price to the consumer has been enhanced through repeated resales by dealers successively buying and selling the same coal, and to institute prosecutions against such dealers, where the facts warrant, for engaging in an "unfair or deceptive or wasteful practice or device" or a "conspiracy, combination, agreement, or arrangement" to enhance the price of coal by such practice or device, in violation of Section 4 of the Lever Act, as amended by the Act of Oct. 22, 1919.

Production of crude oil in the United States this year plus imports will exceed 500,000,000 bbl., according to a prediction by the Geological Survey. The prediction is based upon the record of production for the first half of the present year which shows an output of 214,086,000 bbl., as compared with 178,355,000 bbl. during the same period in 1919. The total output for June is given at 37,219,000 bbl., as compared with 36,931,000 bbl. in May. The daily average production during June—1,240,633 bbl.—was the greatest on record.

The Division of Power Resources of the United States Geological Survey has given out statistics of electrical power production for the first four months of 1920. The average daily production of electricity in kilowatt-hours was as follows: January, 124,700,000; February, 119,700,000; March, 120,800,000; April, 119,700,000. These figures are based on returns received from about 2,800 power plants of 100 kw. capacity or more, engaged in public service.

Personals

James A. Noxon, formerly with Du Pont Engineering Co., Janesville, Wis., is now superintendent, Rock Cut Stone Co., Syracuse, N. Y.

Charles T. Porter, formerly with the Naval Aircraft Factory, Philadelphia, Pa., is now associated with the Huff, Daland & Co., Ogdensburg, N. Y.

Charles Estes Wood, formerly teacher in metallurgy, University of Cincinnati, is now designer and draftsman with the Lunkenheimer Co., of Cincinnati.

Louis A. Delaney, formerly mechanical engineer with F. X. Hooper Co., Glenarm, Md., is now manager of the American Sheet Metal Corporation, of Philadelphia, Pa.

Harry de Lapotterie has resigned his position with the Townsend Company, of New Brighton, Pa., to become industrial engineer of the Falls Rivet Company, of Kent, Ohio.

William D. Cecil has severed his connection as resident material inspector with the Baltimore & Ohio Railroad and is now connected with the Magnus Metal Co., of St. Louis, Mo.

H. Boyd Brydon, mechanical engineer of the Byllesby Engineering and Management Corp., has been appointed a member of the Prime Movers Committee of the National Electric Light Association.

Norris M. Perris, formerly engineer with the Aluminum Castings Co., Cleveland, Ohio, is now industrial engineer of the Industrial Management Council of the Rochester (N. Y.) Chamber of Commerce.

William C. Briggs, formerly sales engineer and New York City manager of the Shepard Electric Crane and Hoist Co., has become vice president in charge of manufacturing of the Franklin Moore Co., Winsted, Conn.

Henry C. Berrian, formerly engineer of the engine scientific department, Federal Shipbuilding Co., Kearney, N. J., is now in the engineering department of the Newport News Shipbuilding and Dry Dock Co., Newport News, Va.

Herbert H. Van Winkle has resigned his position as chief engineer with The Vogt Brothers Manufacturing Co. of Louisville, and is now associated with The John H. McGowan Co., of Cincinnati, Ohio, in the capacity of chief engineer.

Karl R. Kennison has resigned as plant engineer of the Emergency Fleet Corporation in charge of shipyard and drydock construction in New Orleans, La., Mobile, Ala., and Pensacola, Fla., and has opened an office as a power-plant engineer at 18 Tremont St., Boston.

J. Jacques Stunzi, plant study engineer of the engineering department of the E. I. du Pont de Nemours & Co., has resigned his position and accepted an offer as consulting engineer of the Lancaster Steel Products Corporation, a subsidiary of the General Motors Corporation.

Stephen E. Preble, for many years associated with the I. W. Jones Co., Milton, N. H., has been elected vice president and general manager of the Industrial Planning Corp., Buffalo, N. Y., which specializes in hydro-electric development and the design of pulp, paper and fiber mills.

Society Affairs

The Illuminating Engineering Society's convention, which was to have been held in Cleveland Sept. 27-30, will be held in that city Oct 7-10.

The American Institute of Electrical Engineers at a recent meeting of the Board of Directors adopted a resolution to become a charter member of the Federated American Engineering Societies.

Long Branch Association, N. A. S. E., No. 17, of New Jersey, was organized by State Deputy John Reddy on Saturday, August 14. There were 66 names signed to the charter and National President John J. Callahan installed the new officers.

Engineering Societies throughout the United States have received invitations to become charter members of the Federated American Engineering Societies, and also to appoint delegates to attend the first meeting of the American Engineering Council, which will be held this fall at a date to be selected later.

The American Chemical Society will hold its fall meeting with the Chicago Section, September 6 to 10 inclusive. Hotel headquarters will be made at the Congress Hotel. The entertainment committee have arranged a banquet, smoker and excursions. A number of interesting papers and addresses are on the schedule.

The Society of Naval Architects and Marine Engineers, 29 West 39th St., New York City, will hold its twenty-eighth annual meeting, Nov. 11-12, in the Engineering Societies Building. A committee has been appointed to arrange for an excursion to points of interest in the vicinity of New York City on Saturday, Nov. 13. Members will be entertained at a banquet on Friday evening.

The New England Water Works Association will hold its thirty-ninth annual convention at Holyoke, Mass., Sept. 7-10. Headquarters will be at the Hotel Monotuck. A number of interesting papers will be read, including "Experience with an Exploded Pressure Boiler and Check Valve on Service Pipes," by Edward J. Looney, Supt. Water Works, Belmont, Mass., and "Comparative Cost of Pumping by Steam and Hydraulic Power at Manchester, N H.," by James H. Mendell, Supt. Manchester Water Works. Auto trips, theater parties, golf, etc., have been arranged by the entertainment committee for the amusement of the delegates.

The Association of Iron and Steel Electrical Engineers will hold its fourteenth annual convention at the Hotel Pennsylvania, New York City, Sept. 20-24. The convention will open with transaction of routine business, after which the following papers will be read at the various sessions: "Practical Education of Steel Mill Electricians," W. A. Cornwell; "Relations of Standardization in Electrical Equipment to Safety," Walter Greenwood; "Power Transmission for Industrial Plants," D. M. Petty; "Underground Transmission," A. L. Freret; "Some Considerations in the Determination of Auxiliary Drives," Gordon Fox; "Report of Electrical Development Committee for 1920," E. S. Jeffries; "The Reversing Electric Mill Considered from the Standpoint of Tonnage," K. A. Pauly; "Centralized Turbine Generating Stations for Steel Mills," T. E. Keating; "Current Limit Reactance," R. H. Keil; "Report of Electric Furnace Committee for 1920," E. T. Moore, and "Standardization Committee Report," W. T. Snyder. The entertainment committee have arranged several excursions and a banquet for the benefit of the visitors and members.

Miscellaneous News

The West Penn Power Co. has completed installation of one of the two 25,000-kva. units at the $6,000,000 central station at Springdale. The second unit should be operating by Sept. 1.

If the Supreme Court of the United States upholds the decision of the Circuit Court of Appeals at Asherville in the Lamberts Run case, Rush Butler, counsel for the National Coal Association, declares that it will mean an abrupt end for the practice of assigning cars in the coal trade.

In an Effort to Curtail Speculation in coal, a special report has been made to the president of the National Coal Association, recommending that operators be required to satisfy some competent authority that they can give immediate disposition of the shipment before cars are furnished.

Since the Signing of the Water Power Bill by President Wilson applications for more than 500,000 hp. in water power have been filed with the Forestry Service of the Department of Agriculture. Increased fuel costs and transportation difficulties are probably the reasons for this unusual demand.

Hydro-electric development in Arkansas to cost in the neighborhood of $300,000,000 is being planned. Two dams, fifty and sixty feet high respectively, with a total generating capacity of 16,500 kw. are to be erected. Transmission lines 130 miles in length are expected to deliver the 22,000 hp. current for light and power.

The Eastern Wisconsin Railway and Light Co. is to build a large power plant in Fond du Lac soon, according to an announcement by the Kelsey-Brower Co., of Grand Rapids, Mich. A bond issue of $1,200,000 is to finance the plant and also improve the company's property at Sheboygan and Oshkosh.

Under the New Railroad Rates the tidewater rate on smokeless coal will be $2.80. This is an increase of 100 per cent since March, 1917. In making application for increased rates, public utilities in Washington, D. C., estimate that the new freight rates will add 90 cents per ton to the cost of their coal.

The Pacific Gas and Electric Co. will supply the city of Stockton, Cal., with hydro-electric power according to an announcement made by Irving Martin, railroad commissioner. At a hearing which took place recently in Stockton, it was decided that the Pacific company should extend its mains to supply the city.

The Central Illinois Public Service Co. has "hooked up" the last link in a high-power transmission line which is now 1,355 miles long and joins the four states of Illinois, Kentucky, Indiana and Iowa. This single line crosses thirty-one counties. It starts at the hydro-electric development at Kookuk and ends at Louisville, Ky.

Mining Companies of Grass Valley, Cal. are urged by the railroad commission to economize as much as possible in the use of electricity. It is said that a serious shortage will result if this is ignored. No rationing plan has been suggested and it is hoped this may be avoided by the voluntary action of the companies already in force with some of the larger concerns.

John A. Britton, general manager of the Pacific Gas and Electric Co., San Francisco, Cal., has notified the city engineer's office that an increase of 15 per cent will be paid by the corporation for the power it buys from the Hetch Hetchy project. The increase recently allowed by the railroad commission will net the city about $8,000 a month extra.

The Interstate Commerce Commission has announced that coal mines will continue to have priority of use of open-top cars for a period of ninety days from June 21, the date of the original order. The effort of representatives of public utilities companies to have the assigned car feature of the order made to apply to coal for storage, as well as to that for daily needs, was unsuccessful.

The Work of the Federal Water Power Commission, which will have charge of all development under the recently enacted water power act, has been divided into seven departments: Engineering accounting, statistical, regulatory, licensing, legal and operation. The engineering department will be in charge of Lieut.-Col. William Kelly, who has been detailed by the Army Department as the engineer officer of the Commission. A general investigation of the electric power industry, power sites, costs, and development will be conducted by this department. A report covering the results of the investigation will be made to Congress.

Eastland, Texas, Oil Wells are to be pumped and drilled by electric power in central west Texas fields when the power plant of the Oil Fields Electric Co. is finished. The first unit is already in operation. Transmission lines are being constructed to all parts of the petroleum producing region, and within a short time electric power will be used for pumping several hundred wells and drilling many others.

Business Items

The Detroit Valve and Fittings and Detroit Brass Work, manufacturers of iron and brass goods, announce that the name of the firm has been changed to Detroit Brass and Malleable Works.

The Pennsylvania Pump and Compressor Co., of Easton, Pa., announce the opening of additional sales offices in the following cities: Buffalo, N. Y., J. B. Laird, manager; Cleveland, Ohio, L. J. Wakefield, manager; St. Louis, Mo., Corby Supply Co.; Minneapolis, Minn., L. E. Pollard Co., and Omaha, Neb., L. E. Pollard Co.

The Uehling Instrument Co., 71 Broadway, New York City, manufacturer of fuel-economy equipment, announces that it is now represented in the New England States by the Smith Engineering and Supply Co., 89 State St., Boston, manufacturers' agents and engineers specializing in power-plant equipment. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Co. with headquarters in the New York Office.

Dr. E. Vernon Hill announces the formation of a new company in Chicago known as the E. V. Hill Co., Aërologists, with offices at 117 North Dearborn St. "Aërology" is a new term for ventilation, but has a broader meaning, since it includes the physical, chemical and bacteriological phases of ventilation work as well as the mechanical side. For the last eight years Dr. Hill has been engaged in organizing and conducting the Ventilation Division of the Chicago Health Department. During this period he found it necessary to design new instruments and methods for test work, and he now proposes to place some of these instruments on the market for the benefit of engineers engaged in this line of work.

Trade Catalogs

Charles T. Main, designing, consulting and supervising engineer for water-power projects, Boston, has published a 32-page booklet entitled "Hydro-Electric Developments," the purpose of which is to show the work of the organization of Charles T. Main in the design and supervision of water-power structures and hydro-electric systems. Photographic reproductions of work accomplished are shown, together with brief descriptions of plants or special features connected with the same. The frontispiece contains a discussion of the water-power situation. This is followed by an index of the plants where work was done.

Uehling Instrument Co., 71 Broadway, New York City, has issued Bulletin No. 111, describing Style U Uehling CO_2 Equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front CO_2 indicator, which guides the fireman, while the CO_2 recorder, installed in the chief engineer's or superintendent's office, makes a continuous record showing all changes in boiler adjustments.

New Construction

PROPOSED WORK

Mass., Boston—The Supt. of Lighthouses will receive bids until September 7 for furnishing independent beam air pump.

Mass., Longmeadow—Carl Withe is in the market for a ¾ hp., 220 volt, 60 cycle, 2 phase, 1,800 r.p.m., pulley 4¼ diam., 1⅝ in. face motor.

Conn., Bridgeport — **Fletcher,** Thompson, Inc., Engrs., East Main St., will soon award the contract for a power plant addition for the Bridgeport Brass Co., East Main St. About $14,000.

Conn., Hartford—The Bd. Educ. will receive bids until September 7 for a 3 story, 90 x 160 ft. high school on Maple Ave. including steam heating system. About $750,000. Whiton & McMahon, 36 Pearl St., Archts.

Conn., Middletown—Buck & Sheldon, Inc., Engrs., 60 Prospect St., Hartford, will soon award the contract for a 1 story, 30 x 40 ft. boiler house for the Goodyear Rubber Co., 114 Church St. About $30,000.

Conn., New Britain—The Bd. Educ. will soon award contract for a 3 story, 60 x 240 ft. school including steam heating system on Tremont St. About $350,000. D. K. Perry, 27 West Main St., Archt.

Conn., New Haven—The Yale University plans to build a 2 story chemical laboratory including steam heating system. About $250,000. Delano & Aldrich, 126 East 38th St., New York City, Archts. and Engrs.

Conn., Windsor Locks—The Conn. River Co., c/o C. H. Tenney & Co., 201 Devonshire St., Boston, Mass., plans to build a dam, 30 ft. high and 2,000 ft. long, for power purposes.

N. Y., Brooklyn—Maurice E. Connolly, Pres. of the Borough of Brooklyn, Queens Subway Bldg., 68 Hunterspoint Ave., Long Island City, will receive bids until September 8 for furnishing and erecting one high pressure stationary boiler setting, etc., in the Far Rockaway disposal plant.

N. Y., Buffalo—The State Hospital Comn., Capitol, Albany, will receive bids until September 29 for additions to central heating plant and for coal and ash handling equipment at the Buffalo State Hospital, here.

N. Y., Great Neck, L. I.—W. S. Bessell, Archt. and Engr., 56 West 45th St., New York City, will receive bids until September 10 for a 2 story school including steam heating system for Bd. Educ. About $400,000. Noted August 24.

N. Y., New York—The Union Sulphur Co., 17 Battery Pl., is having plans prepared for a 14 story, 30 x 89 ft. office building including a steam heating system on Rector and West Sts. About $400,000. Henry Otis Chapman, 334 5th Ave., Archt. and Engr.

N. Y., Ossining—Chas. D. Rattigan, Supt. of State Prisons, Capitol, Albany, will receive bids until September 15 for addition to power house at Sing Sing Prison.

N. Y., Schenectady—F. F. Proctor, 1564 B'way., New York City, is having plans prepared for a theater building, including steam heating system. About $400,000. J. M. Merron, 1564 B'way, New York City, Archt. and Engr.

N. J., Glassboro—F. H. Bent, Archt., 142 West State St., Trenton, will soon award the contract for a 3 story, 125 x 301 ft. state normal school and a 1 story, 41 x 48 ft. boiler plant. About $700,000.

N. J., Newark—J. H. & W. C. Ely, Archts., Firemen's Trust Bldg., will soon award contract for a 16 story, 100 x 200 ft. office building at Broad and Clinton Sts. including a steam heating system for the Merchants' Natl. Bank, 770 Broad St.

N. J., West Orange—The Bd. Educ. plans to build a school including steam heating system. About $450,000. Guilbert & Betelle, 2 Lombardi St., Newark, Archts.

N. J., West New York (Weehawken P. O.) —The Bd. Educ. received bids for heating and ventilating systems for the new Public School No. 1, from Edward Beck at $60,968.

Pa., Blossburg — The Blossburg Hospital will soon award the contract for a 1 story, 35 x 50 ft. power plant and laundry. About $10,000. G. S. Idell, 1705 Chestnut St., Philadelphia, Engr. and Archt.

Pa., New Castle — The Lehigh Portland Cement Co., 718 Hamilton St., Allentown, had plans prepared for a 3 story, 44 x 140 ft. new waste heat installation power house here.

Md., Frederick — The City Council, City Hall, plans to install one 125 kw. generator, at municipal plant, in connection with the change from arc and incandescent lighting systems to all incandescent. C. L. Reeder, Park Ave. and Saratoga St., Baltimore, Consult. Engr.

Md., Mount Airy — The Hagerstown & Frederick Ry. Co., Hagerstown, plans to construct a 1 story, 25 x 75 ft. substation, etc., here. M. A. Pooler, Genl. Mgr.

Md., Salisbury—The Shoreman's Hotel Corp. will soon award the contract for a 5 story, 71 x 149 ft. hotel including heating system. About $250,000. T. W. Pietsch, American Bldg., Baltimore, Archt.; J. Posey, 11 East Pleasant St., Baltimore, Engr.

Va., Richmond—The Amer. Tobacco Co., 24th and Cary Sts., is in the market for boilers for curing tobacco.

W. Va., Shinnston—The Paquet Glass Co. is in the market for 60 or 80 hp. steam engines and an air compressor. P. J. Paquet, Pres.

Tenn., Clarksville — The Kentucky Pub. Serv. Co. is in the market for boilers, engines, turbines, steam machinery and electrical equipment to be installed in the new electric power plant to be located at 11th St. and the L. N. tracks. Noted June 29.

Ky., Henderson—The City is in the market for a new boiler for the municipal power plant. L. P. Hite, Supt.

O., Cleveland—The City, c/o Dir. Pub. Safety, City Hall, plans to build a 3 story hospital on Scranton Rd. including steam heating system. About $3,500,000. J. H. MacDowell, City Hall, Archt.; Dr. S. S. Goldwater, 1 East 100th St., New York, N. Y., Consult. Archt.

O., Cleveland—The Supervising Archt., Treasury Dept., Washington, D. C., received bids for installing new boiler and remodeling old one in the Marine Hospital here, from Jos. B. Casey Co., Chicago, Ill., $8,360; Becker Seidel Co., Cleveland, O., $10,200; Whittlesey Co., Cleveland, O., $11,457.

O., Cleveland Heights (Warrensville P. O.)—The Bd. Educ., c/o E. K. Bryan, received low bids for power plant on Lee Rd. as follows: general contract from Philip Kirschner, Hippodrome Bldg., Cleveland, $41,382; piping, Warden & Lees, 2450 Prospect Ave., $18,250; chimney, Alphonse Custodis Chimney Co., 95 Nassau St., New York, N. Y.; ash pit, coal and ash handling machinery, The Link Belt Co., Rockfeller Bldg., Cleveland, $18,430.

O., Toledo — H. J. Ricker, 343 Spitzer Bldg., is in the market for five 50 hp., 220 volt, 60 cycle, 3 phase motors and an electrically driven centrifugal pump.

Ind., Bedford—The Bedford Steel & Constr. Co., Engrs. are preparing plans for a canning factory to include conveying systems, conveyors, motors, etc. Owner's name withheld.

Ind., Indianapolis—The American Hominy Co., 1400-15 Fletcher Savings & Trust Bldg., plans to build a 4 story addition to its boiler and power house and install new boilers, generators and other equipment in same. Total estimated cost, $90,000.

Ind., Indianapolis — The Westinghouse Lamp Co., Watsessing Ave., Bloomfield, N. J., will soon award the contract for a 4 story, 100 x 200 ft. factory on La Salle St. here, including steam heating system. About $2,000,000.

Mich., Detroit—The Temple Beth El, 580 Woodward Ave., plans to build a 2 story, 153 x 200 ft. temple, including steam heating and ventilating systems. About $1,000,000. Albert Kahn, Marquette Bldg., Arch. and Engr.

Mich., Grand Rapids—The city is having plans prepared for an additional waterworks system including a pump house and 2 pumps having a daily capacity of 8,000,000 gal., etc. C. A. Paige, City Hall, Engr.

Mich., Saginaw—The Amer. Safety Navigation Co., c/o Managing Secy., Bd. of Commerce, is having tentative plans prepared for first unit of plant to consist of a 1 story factory and 6 story office building. Plans include a steam heating plant and power equipment. Total estimated cost, $10,000,000.

Ill., Chicago—A. Finkel & Sons Co., 1326 Cortland St., plans to construct a 1 story, 32 x 98 ft. heat treating plant. About $20,000. E. M. Newman, 80 West Washington St., Archt.

Wis., Grafton—The Jungers Stove Range Co. plans to install a steam heating system and several electric motors for power in its proposed stove factory on Main St.

Iowa, Manchester—The City, c/o T. Wilson, Clk., is having survey made of pumping station with view to electrifying equipment. A survey of the municipal power plant may be made later. W. E. Skinner, 15 South 5th Street, Minneapolis, Minn., Engr.

N. D., Fargo—The Union Light, Heat & Power Co. plans to repair electric and gas plant here. M. L. Hibbard, Genl. Mgr.

Mo., Butler—The City voted $65,000 bonds to build an electric power plant. J. F. Smith, clk.

Mo., St. Louis—The Little Sisters of the Poor are having plans prepared for addition to institution building and enlargement of present heating plant. About $250,000. Lee & Rush, Syndicate Trust Bldg., Archt.

Mo., St. Louis—Widman, Walsh & Pankem, Archts., Wainwright Bldg., will receive bids until September 15 for a 4 story, 144 x 250 ft. office building including steam heating system on Olive St. for the Lowenstein Bros. Real Estate Co., Wainwright Bldg. About $750,000.

Mo., St. Louis—The Sisters of Charity, 3539 Pine Blvd., are having plans prepared for a hospital on Pine St. including a power house for heating system. About $2,000,000. Lee & Rush, Syndicate Trust Bldg., Archts.

Tex., Austin—The Bd. Educ., c/o A. W. Blanton, Secy., will soon award the contract for administration and dormitory buildings and heating plant. Ross & Read, 208 Bankers' Trust Bldg., Waco, Archts.

Tex., Cleburne — The Cleburne Waterworks plans to install a 150 hp. motor and a compressor with a daily capacity of 1,250,000 gal. W. S. Hockaday, Supt.

Tex., Clifton—The Planters Gin Co. plans to install one 130 hp. oil engine. F. T. Graffenreid, Pres.

Tex., Dallas—The Texas Hosiery Mills, 1407-09 South Ervay St., plans to build a hosiery factory and is in the market for electrically driven knitting machinery for same. James C. Dobson, Mgr.

Okla., Lawton—V. V. Long & Co., Consult. Engrs., 1300 Colcord Bldg., Oklahoma City, has prepared report for new sewage disposal plant and sewage pumping station here. About $200,000.

Okla., Stigler—V. V. Long & Co., Consult. Engrs., 1300 Colcord Bldg., Oklahoma City, have prepared report for extensions to waterworks here, including pumping station. About $35,000.

Col., Denver—The Denver Gas & Electric Light Co. plans to build a 50 x 59 ft. boiler room and install one 750 hp. boiler in same. About $39,000.

Utah, Salt Lake City — The Bonneville Irrigation Dist. has voted to issue $600,000 in bonds for the construction of an irrigation pumping system including a power house. Two 500 hp. and two 900 hp. motors are to be installed in the pumping station.

Cal., Los Angeles—A. R. Erlanger, 214 West 42nd St., New York, N. Y., plans to build a theater, including steam heating system. About $500,000. T. R. Anderson, 214 West 42nd St., New York City, Archt. and Engr.

Cal., San Francisco—A. R. Erlanger, 214 West 42nd St., New York, N. Y., plans to build a theater here, including steam heating system. About $500,000. T. R. Anderson, 214 West 42nd St., New York City, Archt. and Engr.

CONTRACTS AWARDED

Mass., Holyoke — The Lyman Mills, [illegible] Front St., has awarded the contract for altering the power plant to the Casp[illegible] Ranger Constr. Co., 20 Bond St., at $20,00[illegible]

R. I., Pawtucket—The What Cheer Chem[illegible]ical Co., Grotto Ave., has awarded the contract for a 3 story, 40 x 62 ft. boiler house addition to J. F. Cole, 81 Niagara St., Providence, at $50,000.

Conn., Montville—Robert Gair & Co., [illegible] Washington St., Brooklyn, N. Y., has awarded the contract for a 2 story, 200 x 500 ft. manufacturing building and a 1 story, 50 x 50 ft. power plant to the Austin Co., 217 B'way, New York City, at $600,000. Noted June 29.

N. Y., New York—The John J. Buckley Syndicate, 233 B'way, has awarded the contract for an 8 story printing crafts building including a steam heating system on 9th Ave. between 33d and 34th Sts. to the John O. Devlin Constr. Co., 233 B'way. About $3,500,000.

N. J., Union Hill—The Consumers' Hygienic Ice Co. has awarded the contract for an addition to its ice and refrigeration plant to the Selbach-Meyer Co., $29,000.

Pa., Easton—The Y. M. C. A., 9 Centre Sq., has awarded the contract for a 4 story, 105 x 125 ft. Y. M. C. A. building including a steam heating system to Wark & Co., 1239 South Broad St., Philadelphia, at $400,000. Noted March 30.

O., Columbus—The Columbus Ry., Power & Light Co., 102 North Ohio St., has awarded the contract for a 3 story, 25 x 46 ft. substation on East Rice St. to E. J. Spencer, Huntington Bank Bldg., at $25,000.

Ill., Chicago—The United States Industrial Alcohol Co., Inc., 27 William St., New York, N. Y., has awarded the contract for a warehouse on 37th St. and Western Ave., here, including steam heating system, to George A. Fuller Co., 175 5th Ave., New York City. Estimated cost, $500,000.

Wis., Sheboygan—The Jenkins Machine Co., c/o A. H. Studeman, 315 North 8th St., has awarded the contract for a 2 story, 150 x 200 ft. machine shop to Verhulst Bros., 1615 Erie Ave., and is in the market for motors.

Wis., Sheboygan—The St. Nicholas Hospital Assn. has awarded the contract for furnishing boilers and all material and installing same in power house at the institution to Chas. Honold, 821 Penn Ave. Noted August 17.

Minn., Minneapolis—The Flour State Baking Co., E. C. Foley, Secy., 12th and Minnehaha Aves., has awarded the contract for a heating system to be installed in the new 4 story, 60 x 150 ft. bakery plant at 500 East 37th St. to J. J. Egan, c/o owner. Total estimated cost, $250,000.

Mo., St. Louis—The Boyd Clothing Co., 7th and Olive Sts., has awarded the contract for a 6 story, 88 x 150 ft. mercantile building, including steam heating system. About $400,000. T. P. Barnett Co., Arcade Bldg., Archts. and Engrs.

NEED COMPETENT MEN?

SEE THE SEARCHLIGHT SECTION

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